POWER

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The Pat on the Back

MANY a good man has degenerated from an active, interested worker into a listless time server by lack of appreciation.

An engineer enthused with the possibilities of his position, absorbed in an effort to get the most possible out of his plant, planning, watching, keeping records, saving many times his salary, is unable to arouse any interest on the part of or to get any support from his superiors. He sends in a report showing the saving made in the last year or the last quarter and never hears from it again or, if he ventures to present it in person, is treated as though it were suspected of being a bid for a raise.

He chafes under the knowledge of wastes that he knows he could prevent were he allowed to make changes, inexpensive in comparison with the results that they would produce. He feels the slight when the Boss, showing a visitor through his well-kept plant, passes him by without a word of recognition.

If the boss would only say, "This is Mr. Smith, our engineer. He can get more power out of a pound of coal than any man in seven countries. Look at the charts and records he has got there. How much did you save last month, Bill?" he would go farther toward making that man what he said he was than in any other way.

And he would win him for life.

I talked a short time ago with an engineer who has charge of the numerous power plants of a large concern. He had made a success of putting a run-down power plant on its feet; this company learned of him and put him in charge of one of their plants.

A short time after he took hold, he went up to the office and inquired about the cost of things. The effect was much as though a kitchen girl had invaded the parlor during a pink tea and demanded to know the price of the tea service or table cover. He could be given such figures only with the permission of Mr. So-and-So, and Mr. So-and-So did not see that they were any of his business.

He had no further argument with Mr. So-and-So, but the next time the president, who had hired him, was there, he went to him as though he was expected to go to him like any other head of an important department. He told him of the condition in which he had found things, what he had done and was trying to do. He interested the president in him and in his job. He demonstrated that he was master of the situation. And when he showed some of the accounts that he was trying to keep and explained his need for information as to costs, etc., Mr. So-and-So was summoned and told to give him what he asked for, whenever he asked for it. And now he is in responsible charge of all the power plants and one of those with whom the president consults frequently and interestedly.

This man made himself appreciated.

There are a half-dozen other engineers, each of whom is running one of the plants which he is supervising.

The president might very likely pass any one of them by in passing through his plant.

A man to be appreciated must, first of all, have the goods. And then he must have the faculty of letting it be known that he has them and that they are the real thing.

And he would more often have the qualities that would make him valuable if, when he shows a real interest in his day's work and wants to be something more than a "hand," he gets a pat on the back and a word of commendation.

F. R. Low

Ash Handling in Large Generating Stations

By L. R. LEE
Chief Engineer, E. W. Clark and Company Management Corporation

Dealing with the handling and disposition of furnace ash, wherein several designs of ashpits are described and the merits or demerits of each are brought out. It is shown that the handling of ashes and their disposition is one of the three big factors in power-plant operation. The several methods of ash disposal are described and also the provisions that must be made in case there is a failure in the operation of the ash-disposal system employed.

ASH handling is an important operation in the modern plant. In the old days, when anything over 10,000 kw. was a large plant and good coal was generally used, the quantity of ash produced was not large and its removal of minor importance compared with various other power-plant matters. However, it will be generally agreed that today the ash-removal or disposal matter is one of three big factors, the first two undoubtedly being coal and water.

A number of elements have given the ash question increased importance in recent years. It has been found necessary and desirable to burn large quantities of low-grade or high-ash coal. Improvements in the stoker equipment have made it possible to burn these high-ash coals and still obtain relatively good efficiencies and high boiler capacities. From the viewpoint of the power plant a coal is desirable in proportion to its cost per kilowatt-hour. The modern stoker has accomplished much in making low-grade coal cheap and satisfactory for power-plant purposes. Also power plants in recent years have been constructed of such large capacities that the actual quantities of coal and ash handled per day in a single plant are enormous.

Design of Ash-Handling System

There may be many various opinions as to the design of an ideal ash-handling system, but regardless of what different engineers might consider of major importance, the result that all are striving for is somewhat as follows: The ash-disposal system must receive ash from the stoker and remove it to its ultimate destination at the least expense, including fixed and running cost, creating no bad operating effects on equipment or men.

There are four operations or steps involved in handling ash: First, cleaning or dumping the stoker; second, storing ashes in a pit or chamber immediately below the stoker; third, removing or transporting from the ashpit to the railroad car, barge, truck or storage outside the station; fourth, transportation of the ashes to some final resting place such as fill, railroad grade, body of water or old mine.

The first step (the stoker ash dump) is one that must be provided for largely by the stoker manufacturer. With the chain-grate type of stoker the ash-discharge is continuous; with the underfeed type the dumping may be intermittent or continuous, depending on the detailed construction of the stoker. However, with any stokers of the forced-draft type more clinkers and of larger size may be, and usually are, produced than will be obtained with the natural-draft stoker or the chain-grate type. Clinkers have complicated the ash problem, for obviously it is one thing to handle soft, fine ashes, but quite another one to handle slag bodies weighing fifty to one hundred pounds each. As a result of this we have clinker grinders as a part of the standard equipment furnished with some stokers.

The second step (the receiving ashpit) is also an important one and it must be taken care of in designing the plant. Its functions are threefold: Temporary storage space to allow intermittent transportation; to allow the ashes to cool for more satisfactory transportation without damaging the stoker, furnace or foundations; to prevent cold air coming into the furnace or hot gases from the ashes or the furnace getting into other parts of the plant.

Determining Size of Ashpit

The size of the ashpit is largely determined by the rate of burning coal in the furnace and the nature of the transportation facilities as given under the third step, that is, removing ashes from the station to some outside point. If high-ash coal is to be burned at a rapid rate and the boilers are to be served by a car system, then a pit of generous capacity is desirable if not absolutely necessary. It is also important to have some distance between the bottom of the ashpit and the stoker dump so that the hot ashes may not cause the stoker parts to become overheated. If the ashes may be allowed to cool without too much water being sprinkled on them, so much the better. If the pit is large and contains most of the time considerable dead ash, the freshly dumped ash will cool on the surface of this ash pile, thus being insulated from the foundation and walls of the ashpit itself. The pit must be tight and provided with gates, doors or other means of closing the openings. It is as essential to keep the hot gases in the pit as it is to keep cold air from getting into the pit and thence to the furnace.

The third step (removing ashes from the ashpit to outside the station) involves the use of mechanical equipment. Thus the stoker design provides for cleaning the furnace and discharging the ashes into a pit, which is part of the plant design. Thus far the ashes are removed by gravity—from this point on it is a matter of transportation and labor. The ideal design would perhaps be one in which no labor is involved and minimum equipment used to secure transportation from the pit to the outside point. There are three practical and typical ways of removing or providing this transportation of ash: Raking or dumping the ashes from the pit into manually operated conveyances such as wheelbarrows, push cars, etc.; conveyors, either mechanical, steam, pneumatic or hydraulic; power-driven cars, either industrial or standard railroad design.

System Limited to Small Plants

Under the first, considerable labor is involved, but the investment in equipment may be low. However, the capacity that may be so handled is limited by space required for men and conveyances to operate and the distance that must be traveled from the ashpit to the outside station point. Such a system is obviously

limited to the small plant, where the distance from the farthest stoker to the outside disposal point is not more than 100 to 200 ft., and also where the quantity of ashes that must be handled in 24 hours is only a matter of say two or three carloads.

Under the second method the investment is larger, but the labor required is a minimum. Any of these systems will require some operating labor; it is not practical to make them automatic. Conveyors must be provided in duplicate if shutdowns are to be avoided. In every case there is considerable wear on the equipment caused by the movement of the mechanical parts in the presence of ashes or by the movement of ashes over metal parts. Ash is an abrasive of no mean ability.

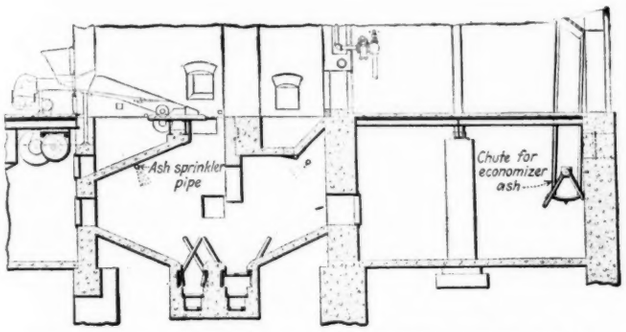


FIG. 1. UNDERFEED-STOKER ASHPIT WITH DRAG-CHAIN ASH CONVEYOR

Under the last-mentioned method the big advantage is that the ashes come into contact with no moving parts and each conveyance or car is a complete unit which may be taken out of service at will for repairs or renewals. This system may be cheaper than any other so far as the equipment itself is concerned, but many parts of the plant will have increased cost thereby, as will be explained later.

As to the fourth step (transportation of ashes from the station) there are practically but three ways to move ashes from the station to some distant point—railroad cars, motor truck and barge. Many plants along the seaboard use barges; those situated in large cities generally use railroad cars, but many use motor trucks to a considerable extent, and plants built in isolated localities may dispose of large quantities by local filling. In any of these cases it may be found necessary to have some storage to compensate for the irregularities of the transportation facilities.

Ashpit For Underfeed Stokers

The advantages and disadvantages of different ash-handling arrangements can be best appreciated by studying some actual layouts. Figs. 1 to 6 show different arrangements for different systems.

Fig. 1 shows an ashpit for underfeed stokers, the ashes being removed from this pit by a drag- or scraper-chain conveyor arranged in duplicate. This ashpit is installed in a basement 10 ft. 6 in. high and receives the ashes from the stoker and the fine ash that is carried over in the third pass of the boiler setting. This pit will accommodate approximately 1.5 tons of ashes per foot of width. This type of pit is built into the foundation for the boiler and is constructed of reinforced or mass concrete, the sides of the pit being protected by firebrick. Under normal operation the pit is closed and the ashes are taken out through the conveyors intermittently. The ashes fall from the stoker dump in about the center of the pit, forming a ridge sloping off toward the doors. Whenever it is desirable to remove the ashes, the gates to one conveyor are opened and the ashes fall onto the conveyor. This type of ashpit has a maximum volume for depth of basement and uses all the space within the foundation walls which are required for the boiler. It adds a minimum of expense to the foundation of the boiler and will involve a minimum maintenance cost. It may also be stated that the fine ash which may be carried into the economizer can be taken out of the chute in the basement and placed in the conveyors. This is accomplished by the use of a small manually operated push car dumping the ash onto the conveyors between the foundation of one boiler and that of another.

The scraper conveyors discharge onto an incline conveyor at the end of the boiler plant, which in turn elevates the ashes at an angle of about 30 deg. and discharges into a hopper over railroad cars. In this case the hopper over the car has a small capacity, so that it is necessary to have cars on hand constantly in order to take care of the ashes.

Confusion of Ashpits

Comparing the arrangement in Fig. 1 with Figs. 2 and 3, it will be seen that the basement in the latter cases is 15 ft. high and that the volume of the ashpit is comparatively small; also, that a separate compartment is provided to receive the fine ash from the third pass, Fig. 2. This particular hopper is made of steel, lined with firebrick and provided with a cast-iron gate. Since the hopper is comparatively small, it is necessary to use considerable water for cooling the ashes, which will cause corrosion in the metal work of the hopper, especially the steel sides. This type of hopper will eventually leak air to some extent and will continually drain water onto the basement floor, carrying with it a certain quantity of fine ash. This style of hopper is also supported under the boiler, and the boiler foundation itself is made up of a combination of structural steel and concrete.

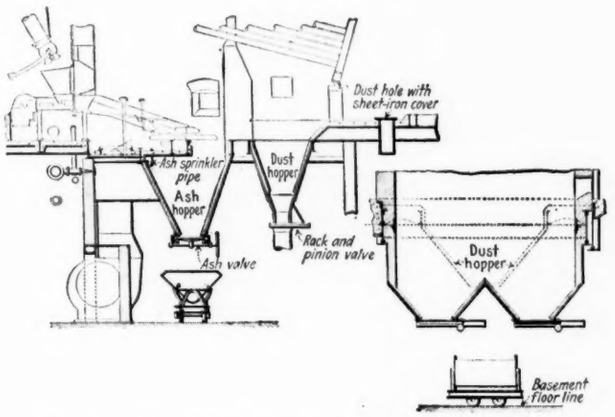


FIG. 2. ASH HOPPER, ALSO FINE-DUST HOPPER FOR THIRD-PASS ASH

Fig. 3 shows a similar arrangement where a chain grate is used; the fine coal from the chain grate is caught and taken care of by the same car that may take care of the ashes. In this particular system the cars are pushed out by an operator, at the end of the station, and dumped into a pit. A monorail crane

provided with a clamshell bucket removes the ashes from the pit and loads them into a railroad car. Fig. 4 shows a better-designed hopper, using the same base-hopper, using the same basement height. The capacity of this hopper is approximately one ton of ashes per foot of width.

Fig. 5 shows an arrangement for taking care of ashes and fine coal from a chain grate by the use of a scraper- or drag-chain conveyor. In this case the conveyor dis-

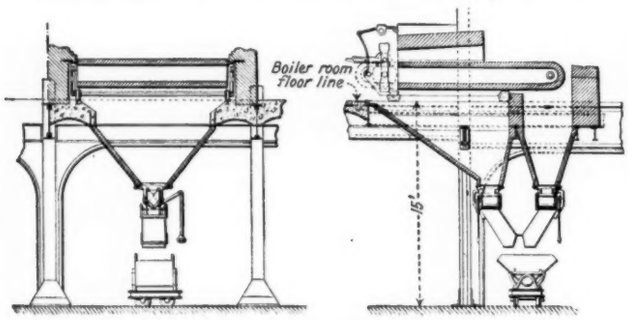


FIG. 3. A COMBINATION ASH AND FINE-COAL HOPPER

charges either ashes or fine coal at the end of the boiler plant, where both the ashes and the fine coal are elevated to different storage bins. The ashes are carried upward by means of a bucket elevator and the coal is carried by a similar method. The ash hopper in such case is made of structural steel and lined with concrete. The weakest part of such a system is the bucket elevator, but for this particular installation (which is a small one and the elevator is not extremely long) the system works well and has a reasonable maintenance. Where such a plan is carried out on a large scale, using a high elevator, the maintenance cost usually becomes excessive.

Fig. 6 shows a large-capacity ashpit served by railroad car. In this case it is to be noted that the depth of the basement is 31 ft. 4 in. The increased height in this basement over that shown in Fig. 1 is practically chargeable to the railroad-car system. These six figures have shown a variety of typical means of handling ashes. For example, in Fig. 1 the conveyors could be removed and a stream of water passed through the conveyor trough, giving an arrangement that would be suitable, with some changes, for the hydraulic handling of the ashes. In the same way ejector pipes could be installed at some suitable location and we would then have the steam or pneumatic ash-handling plan.

Different Types of Ashpits

It is to be noted that the common points among any of these different types of ashpits are as follows: The boiler-room floor line is the dividing line between the handling of coal and ashes. The ashes are dumped from the stoker into the ashpit at approximately the boiler-room floor level. With the underfeed type of stoker, especially with the clinker-grinder attachment, the ashpit may be considerably below the boiler-room floor line; on the other hand, the chain-grate dump may be considerably above the floor line, also the dump may be about central with the boiler foundation. This is especially true with a double-end stoker or with a single-end stoker set in the conventional manner, as shown in Fig. 1. Where a single-end stoker of extra length is used with the alert setting of the boiler, the ash dump may be somewhat to one side of the center of the foundation. In all cases it is necessary that considerable protection be used to prevent the ashes when dumped from damaging the ashpit or the foundations of the boiler.

Where the ashpit is constructed as in Fig. 1, it is only necessary to line the foundation with firebrick. Occasionally, this lining will have to be renewed, but it is a job that can be done when other boiler work is going on and is neither difficult nor expensive. Where the ashpit is arranged as under Figs. 2 and 3—that is, a suspended pit made up of structural iron—the lining of firebrick is still a necessary item, and in addition to this it is well to protect as much as possible the steel from the corroding effects of the ash. If the hopper can be made large enough, a concrete lining could be used to advantage, but where the hopper is very small the extra thickness of concrete will make considerable reduction in the volume of the pit. The big advantage of a large ashpit is that the ashes may remain in it for some hours and a quantity of dead ashes may be allowed to remain on the floor of the pit, so that as the hot, fresh ashes are dumped, the pit will have a layer of dead-ash insulation. As the quantity of dead ashes accumulates, they will help to cool the fresh ashes and clinkers and reduce the requirements for water sprinkling.

Quenching Hot Clinkers and Ashes

Sprinkling to quench the hot and burning portions is necessary where the ashes must be handled rapidly from the pit to the outside of station, and the use of a large quantity of water is more or less of a nuisance as all water must eventually be carried to some drainage system and must carry with it a certain amount of fine ash. This drainage will usually attack any metal work and must be carried through concrete or clay sewer tile. Also, the drain passages must be large and

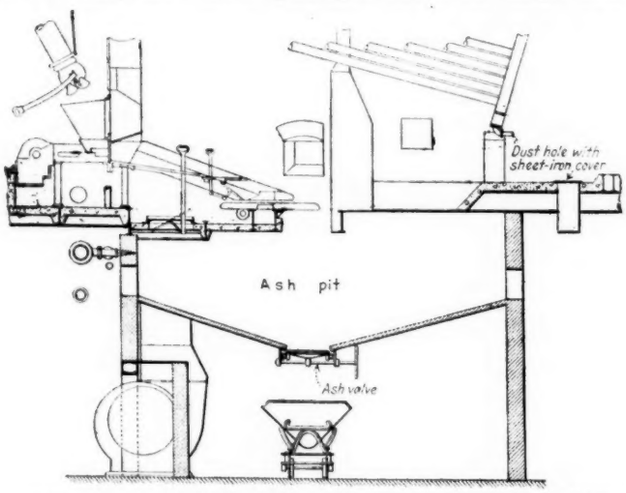


FIG. 4. A BETTER DESIGN OF ASH HOPPER THAN THAT SHOWN IN FIG. 3

as free as possible from turns, and at convenient intervals it will be necessary to install manholes for cleaning out fine-ash deposits. An ashpit of generous proportions is a good start on a satisfactory handling system.

The third operation—that is, the transportation of the ashes to outside of station—is, of course, a most important one, and there are two or three points that must be borne in mind if a satisfactory arrangement is to be made.

First: Whatever plan is used, arrangements must be

provided for renewing any part of the equipment in a minimum length of time or provision made for duplicate equipment. The arrangement as shown under Fig. 1 shows duplicate conveyors, one having sufficient capacity to handle an entire row of boilers. This arrangement is so made that one conveyor may be overhauled while all of the boilers are in operation and

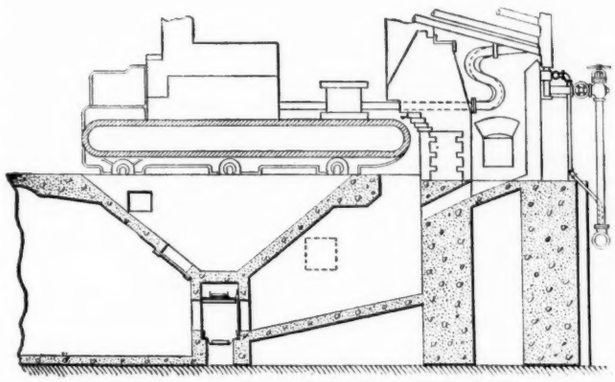


FIG. 5. ARRANGEMENT FOR TAKING CARE OF ASH AND FINE COAL SIFTINGS FROM STOKERS

while ashes are being removed by the use of the other conveyor.

The great advantage of the industrial-car system is that the car itself is a relatively small and inexpensive unit, can be repaired outside the station at any time, and will not in any way interfere with the removal of the ashes from the station, provided there are other cars to take its place. The additional space required under Fig. 6 for bringing of the railroad car into the station itself involves rather a heavy expense in increased building volume, increased cost of boiler foundation and ashpit. It would seem that such expense could well be avoided by bringing the car only to the end or side of the boiler plant, using any convenient horizontal transportation idea for carrying the ashes from the pit to this outside plant.

It is often thought that when ashes are dumped into a car at the outside of a station, they must be elevated at a considerable height to suit the convenience of the railroad grade. Many poor arrangements have been tried and much maintenance cost has been involved in plans for raising the ashes to different heights, emptying then into different arrangements of bins where they are held for discharging into the cars. It would seem much more reasonable to go to considerable effort to depress the railroad track. The difficulty, however, of arriving at such a desirable arrangement is that when the ashes are removed by means of a conveyor or small industrial car from the ashpit to the outside point, it is necessary to provide for two vertical distances for the ashes to fall by gravity. First, they must fall from the ashpit into the conveyor or industrial car, and second, they must fall from the end of the conveyor or from the industrial car into a suitable pit.

Outside Coal Storage

It is unwise to provide no storage at the outside of the station, requiring the conveyor or industrial-car system to dump immediately into the railroad car. The irregularity of car service is a contingency that must be provided for. Even if the cars are provided as part of the plant equipment, there will be times when it will be impossible to set them on the track with proper regularity. Therefore, it is best to provide the pit at the end or side of the station into which a conveyor or industrial car may dump and then to provide means for lifting the ashes from this pit into railroad cars as desired. There are many ways of lifting ashes in such cases, such as bucket elevators, skips and clamshell buckets. Undoubtedly, the skip hoist or clamshell bucket will give the most reliable and satisfactory service where large capacities are required. The clamshell bucket may be operated from either a monorail crane or other type of traveling crane, or it may be attached to the boom of a locomotive crane or stationary derrick. The clamshell bucket is probably the most sturdy arrangement that can be used and one that has almost unlimited capacity, depending only on the size of bucket and the capacity of driving mechanism allowing high-speed operation.

Considering Location Factors

It is necessary to consider different factors in different localities. In cold climates it is advantageous to handle the ashes as dry as possible. In such case a large pit where the ashes will almost cool themselves is desirable. Also in such climate the hydraulic method would have some disadvantages, as the very wet ashes deposited in railroad cars would probably cause considerable trouble due to freezing in the cars. Then, too, in a very cold climate it is well to have an arrangement such that the basement of the boiler plant may be kept closed as much as possible to prevent the entrance of cold air. Cold air currents and much use of water and sprinkling will cause steaming and fog, which will

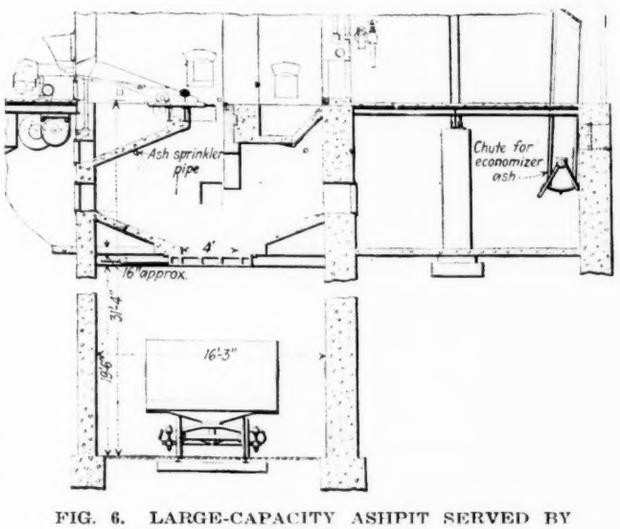


FIG. 6. LARGE-CAPACITY ASHPIT SERVED BY RAILROAD CAR

not only make the basement disagreeable to operators, but also cause corroding of all iron or other metal parts in that section of the plant.

Of all the different materials that may be used in constructing the different parts of the ash-storage and removal system, mass concrete is probably least affected of any. Thick sections of reinforced concrete are also satisfactory, and in any case the concrete must be protected with firebrick where it may come in contact with the hot ashes. Hot ashes and much use of water will

cause concrete to spawl. In the metals cast iron is by far the best and least affected by ashes; next to this, malleable iron, but any structural steel section or steel plate is quickly affected by ashes and will have a high depreciation. There is some high-grade steel plate made that will resist, to a considerable extent, the action of the ashes, and where it is necessary to use plate, the very best that can be bought should be used. In using firebrick lining it has been found satisfactory to lay the firebrick in a rich cement mortar.

There are many arrangements in use for preventing clinker from becoming attached to furnace walls. There is the patented ventilator side wall, which is intended to prevent clinker from forming along the side of forced-draft stokers. This may also be applied to the bridge wall along the line of the ash dump. In some cases this wall is made up by holes or joints in the brickwork; in others special tile with holes are used, and in some cases tile and cast-iron blocks are used. There are also arrangements of water legs and water boxes used with chain grates and with the forced-draft underfeed stokers to prevent the sticking of the clinker at the bridge-wall or ash-dump line. Any of these may be made to work successfully, but where coal clinkers badly it is usually necessary to take advantage of some such plan in order to make the operation satisfactory. In any case it is still considered desirable and necessary to provide clean-out doors at the side or back part of furnaces so that at times the fireman may use bars for breaking up clinkers and help in dumping the stoker. There are also many coals that run rather uniform and that do not cause much clinker trouble and hence do not call for a great deal of furnace cleaning.

Ash Disposal Sometimes Difficult

The limitations of the disposal of the ashes are numerous. It is no longer possible to get all railroads to take them and provide transportation for them. As time goes on, it will probably be necessary to pay transportation on all ashes removed from stations, and it has also been found difficult at times to get a regular supply of cars. This, however, usually works itself out, as the cars that bring the coal to the plant are usually suitable for removing the ashes. With stations using large seasonal storage there are times when coal-car service is irregular. Owing to the fact that generating stations are becoming of such large capacities and also because they are able to burn such low-grade coals, the ash output from many plants has become such that the actual space required to receive the ashes in a period of years must be very great. Often, ashes can be used in grading around new plants for a considerable time, and full advantage is always taken of such opportunities. Railroad companies usually are glad to get ashes for filling, but they do not desire them for the railroad bed as they pulverize rapidly. Probably the only plants that have unlimited possibilities for ash disposal are those along the seaboard, where the ashes are taken out in barges and dumped at sea. In several instances old mines have been used for ash disposal.

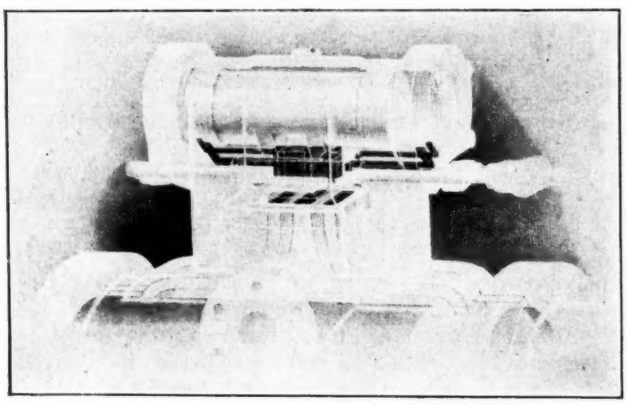
When heat is turned into work or the reverse, the "rate of exchange" is 778 ft.-lb. of work for each B.t.u. For example, if a weight of 778 lb. falls freely through a distance of one foot, the heat generated by the impact is one B.t.u., an amount suffiicient to raise the temperature of one pound of water one degree F.

Warren Eclipse Pump Valve Gear

The Warren Eclipse Pump valve gear is designed to provide positiveness of operation, economy of steam consumption and increased over-all pump efficiency. Its design is as follows:

A lever is mounted on a fulcrum pin held by a pedestal. At its lower end it is connected to the piston-rod crosshead by a link, and near its top is mounted a pin upon which rests a tappet. On the valve-rod link are mounted two adjustable tappet collars, between which the tappet moves as the lever is moved back and forth by the action of the piston rod. These communicate the action of the tappet through the valve-rod link and knuckle to the valve rod. The valve rod is connected inside of the steam chest to the valve yoke, which is set over the stem of the main side valve and through its full travel carries with it the auxiliary valve, which is set at one side.

Toward the end of the movement of the yoke it is brought in contact with the stem of the main slide valve,



PHANTOM VIEW OF PUMP VALVE

slowly moving it until the auxiliary valve operates the valve-driving piston. This latter action is accomplished as follows:

Just as soon as the valve rod begins to move, the auxiliary valve closes the exhaust and opens the steam port of the valve-driving piston, admitting steam to the end from which it had last been exhausted; this balances the valve-driving piston, which remains so until the main slide valve has been moved to near its central position; at this point the auxiliary valve closes the steam and opens the exhaust port on the end toward which the valve-driving piston is moving, allowing the remainder of the movement of the slide valve to be completed by the unbalancing of the steam pressure on the valve-driving piston. This causes the pump stroke to be reversed.

This pump valve is manufactured by the Warren Steam Pump Co., Warren, Mass.

The weight of a round bar increases as the square of the diameter, the bending strength as the cube and stiffness as the fourth power. Therefore if the diameter of such a bar is doubled the weight will be four times (2×2) as much, the bending strength eight times ($2 \times 2 \times 2$) as much and the bending stiffness sixteen times ($2 \times 2 \times 2 \times 2$) as much as that for the original bar.

The Maxim Silencer in the Power Plant

WHEN one hears of the Maxim Silencer, one naturally thinks of firearms, but it has developed usefulness in other fields, among which is that of power-plant apparatus.

Hiram P. Maxim, of Hartford, Conn., the inventor of the silencer and president of the Maxim Silencer Co., says that having conceived the idea, he was puzzled to

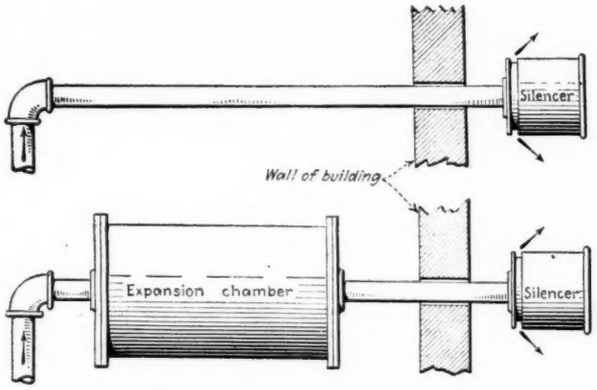


FIG. 1. SILENCER AT END OF EXHAUST PIPE
Upper—without expansion chamber; lower—with expansion chamber.

find a hole that would let the bullet out and keep the gasses in, or let them out with reduced velocity. One morning, watching the vortex that had formed about the outlet of his discharging bath, he said "there is the hole," and upon the principle there suggested perfected the inventon.

Unable to arouse any interest in it on the part of our Government, he took it to Germany—it was before the war. There, after searching tests, he met with enthusiastic approval, and a dinner attended by military,

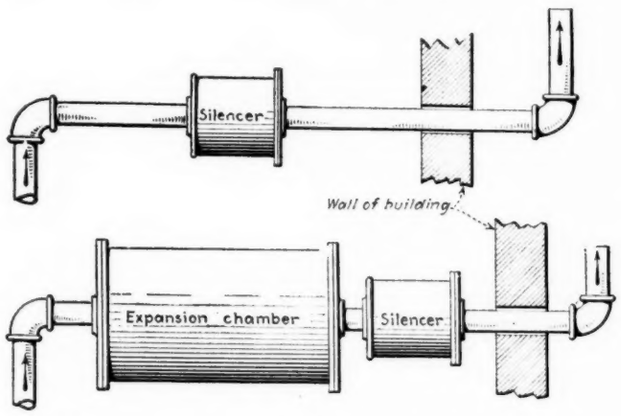


FIG. 2. SILENCER IN EXHAUST OR INLET LINE
Upper—without expansion chamber; lower—with expansion chamber.

naval and government dignitaries was given in his honor. When the time arrived for him to speak, the gentleman who introduced him began in this wise: "One time Herr Maxim thought he would take a bath."

On account of patents now pending, it is not possible at present to describe in detail the silencer as modified for such uses as will interest power-plant engineers. It is possible, however, to give a general outline of its applications in this field.

As might be expected, these silencers have been frequently applied to the exhausts of oil and gas engines, but there are many other uses for them around the power plant. Applications have already been made to the following: Oil- and gas-engine suctions, compressed-air unloaders, unaflow-engine exhausts, steam safety valves, air hoists, steam and air discharges from special apparatus (such as curing ovens). It is to be expected that many new applications will be found as time goes on.

General Description

Although, as already stated, the details of construction are not yet available for publication, a general description can be given. The silencer unit is made of sheet steel with heads of gray iron. The whole surface is coated with a mixture of asphaltum and asbestos, which has been found to resist corrosion. Where the

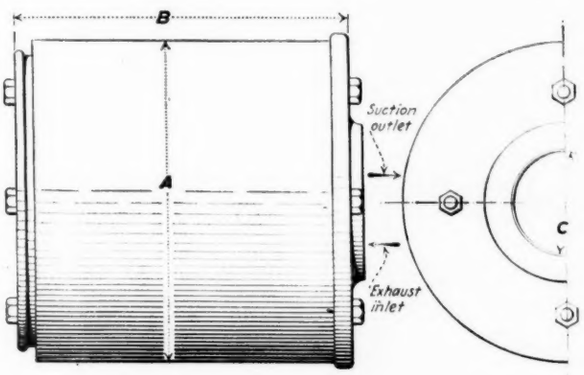


FIG. 3. DIMENSIONS AND WEIGHT OF SILENCERS

C, Pipe Size, In.	A, In.	B, In.	Weight, Lb.
1	4	4	10
2	7	8	25
3	13	10	45
4	16	14	100
6	21	19	250
8	27	25	500
10	33	32	900
12	40	39	1,200
14	46	46	1,400

exhaust or discharge is especially corrosive, as is frequently the case in ordinary oil engines using a fuel high in sulphur, the silencing chambers are made of gray iron. In this case the silencer is naturally somewhat larger and heavier.

Fig. 1 shows the style of silencer used on the end of an exhaust line either with or without an expansion chamber. Fig. 2 shows another type, which is used where the silencer is placed in a suction or exhaust line.

A Maxim silencer may be applied to the end of an existing muffler system, or it may be used to replace a muffling pit. The latter is a satisfactory silencing device, if properly constructed, but has the disadvantage of not being readily moved.

The dimensions and weight of the silencer for various pipe sizes are given in Fig. 3. It will be seen that its diameter is roughly 3½ times that of the intake pipe, and that the length is about equal to the diameter. This rough formula applies to all sizes from 1-in. inlet up to 14-in. inlet, so that the dimensions of the device can readily be approximated for any size of pipe.

A Combined Hydro and Semi-Diesel Plant At Minnedosa, Manitoba

Semi-Diesel Engines Installed in a Canadian Hydro-Electric Plant To Carry Load During Periods of Low Water

THE Manitoba Power Commission was established in 1919, under authority of an Act passed by the Legislature of Manitoba, with the object of supplying electrical power to the towns throughout the province of Manitoba. This province covers an extensive territory, and at present towns are so widely separated that an undertaking to link them on one long transmission system would be, economically, almost an impossible problem.

Since its appointment the Manitoba Power Commission has installed about 120 miles of high-tension transmission lines, supplying power to the City of Portage la Prairie, and the towns of Carman, Roland and Morden. The actual power is supplied by the City of Winnipeg Hydro System and is stepped up from 12,000 volts to 66,000 volts. Two other towns (Virden and Minnedosa) are supplied with power by means of isolated electric power plants, and the object of this article is to describe the power plant installed at the latter point. Minnedosa is situated about 150 miles west and 25 miles north of Winnipeg, has a population of about two thousand and is a divisional point on the Canadian Pacific Railway. Some years ago a local company was formed to harness a waterfall on the Little Saskatchewan River, and a hydro-electric plant was installed. An earth-embankment dam about three-quarters of a mile in length was built, allowing of quite extensive water storage and the development of a head of twenty-five feet. A six-foot penstock led to the power house, where a horizontal-shaft turbine was connected to a 375-kva. generator. This penstock and dam are shown in Fig. 2, the old wheelhouse being alongside the new engine room. The drainage area had not been thoroughly studied, and consequently, when the plant was put into operation and service started, the company faced the fact that during the winter months no water flowed into the reservoir, so that plant operation was possible only from eight to nine months in the year, and during the season of greatest need—the winter—there was no delivery of power. The company spent a large sum of money in the endeavor to remedy this condition, but finally was obliged to cease operations and go into liquidation owing to the impossibility of financing the utility.

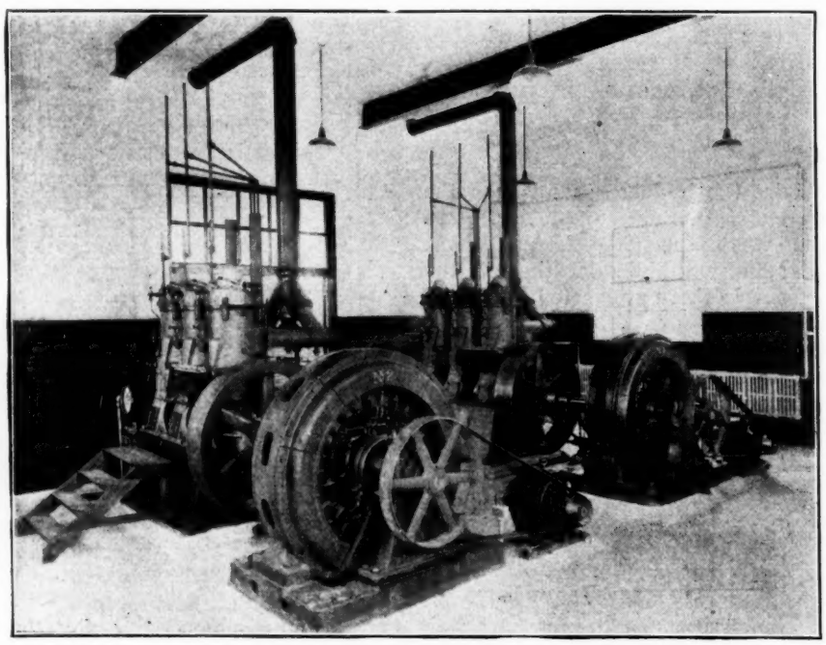


FIG. 1. SEMI-DIESEL OIL-ENGINE UNITS

At that juncture the Town of Minnedosa asked the Power Commission for relief. A complete survey of the watershed was undertaken, and it was found that the only possible economical solution was to take over the hydro plant and to supplement it with a new plant.

Taking into consideration the fact that in the southwestern part of Manitoba and near its border in Saskatchewan there are found quite extensive deposits of lignite, a steam power house was considered. In its natural state this coal is very difficult to burn on the furnace grates, so a study was made of the possibilities of using lignite in a pulverized state. The studies showed, however, that the cost of the process would be prohibitive, and the scheme was abandoned. The installation of a gas-producer plant was then considered, but this also was found to be economically undesirable, and it was finally decided to install fuel-oil engines of the surface-ignition, or what is usually termed the semi-Diesel type.

To house these engines, a new building was designed and erected near the old plant, with extensions to accommodate a redesigned hydro plant to replace the old one and to allow for additional semi-Diesel engines if required. This new building is shown in Fig. 2.

The power house is heated by means of a small hot-water boiler installed in the back of the building. Two concrete tanks, having a capacity of 6,000 Imperial gallons each (7,200 U. S. gal.), for the storage of fuel oil, were built under the storeroom. The construction of these tanks was carefully checked. Waterproofing was mixed with the cement, and when completed, the inside walls were coated with a special waterproofing solution. These tanks have proved entirely satisfactory. The fuel used, known as fuel oil, has a gravity

varying from 26 to 36 deg. Baumé. The light oil is used during the winter months on account of the better fluidity when cold.

Semi-Diesel engines built by the Venn-Severin Machine Co., of Chicago were purchased. The generators and switchboards were supplied by the Canadian Westinghouse Co. The present plant consists of two units, each composed of a three-cylinder two-cycle 120-hp. 300-r.p.m. semi-Diesel engine direct-connected to a three-phase 2,200-volt 81.5-kva. generator, with belted exciter. A leather-belt flexible coupling connects the engine shaft to the generator shaft. This flexible coupling was found necessary owing to the fact that the engine and generator are not mounted on one bedplate and shaft alignment under this circumstance, would be difficult to maintain.

Several special features make these engines very suitable for parallel operation. The governor is designed in such a way that the governing mechanism holds open the suction valve of the pump for a varying length of time, this being determined by the power requirement of the load. The fuel injection takes place at the same crank angle at all loads, the duration of injection being altered to suit the load. The result is that the function of the governor is sure, and the speed variation of the engine under variation of load is almost nil. This permits an easy parallelling of the generators. For synchronizing purposes it was specified that the governor of either engine could be controlled from the switchboard, and a special electric control has been developed which allows the engineer to control the speed of the incoming unit, when synchronizing, without leaving the switchboard. The speed-regulation device on the governor is geared to a small motor mounted on the governor case. By proper manipulation of the switches the engine speed can be varied at will. This feature has been proved quite practical, and as one man only is at any time in attendance, he can, by this means, parallel the generators easily. The engines are started by compressed air, the air-starting mechanism being mounted at the lower end of the governor shaft. Patented oil-seal metal packing is directly set in the crank throws. Inspirators are supplied with try cocks to remove air from the fuel line when necessary.

A graphic tachometer has been installed on each one of the engines, and charts or logs are mailed every day to the head office, where records are kept of the operating features of the plant.

The tests made on the engines gave the results shown in Table I.

TABLE I. TEST OF SEMI-DIESEL ENGINES

Number of cylinders	3
Diameter of cylinders, inches	12¼
Length of Stroke, inches	13½
R.p.m.	300
Total weight of engine, pounds	18,000
Weight of flywheel, pounds	2,000
Normal output, b.hp.	110
Overload capacity, b.hp.	130
Mechanical efficiency, per cent	80
Fuel consumption, no load, pounds (total)	23
¼ load, pounds per b.hp.	1.00
½ load, pounds per b.hp.	0.75
¾ load, pounds per b.hp.	0.63
Full load, pounds per b.hp.	0.57
20 per cent overload, pounds per b.hp.	0.59

The fuel used during the test had a gravity of 28 deg. Baumé and a heating value of 19,000 B.t.u. fuel. Injection water was used sparingly on three-quarter load and quite freely on full load. Cooling water used was 400 gal. per hour or 3.3 gal. per b.hp., the discharge temperature of which was on an average 100 deg. F. The consumption of lubricating oil was one-third of a gallon per hour, making the full-load consumption equal to 0.0028 gal. per horsepower-hour.

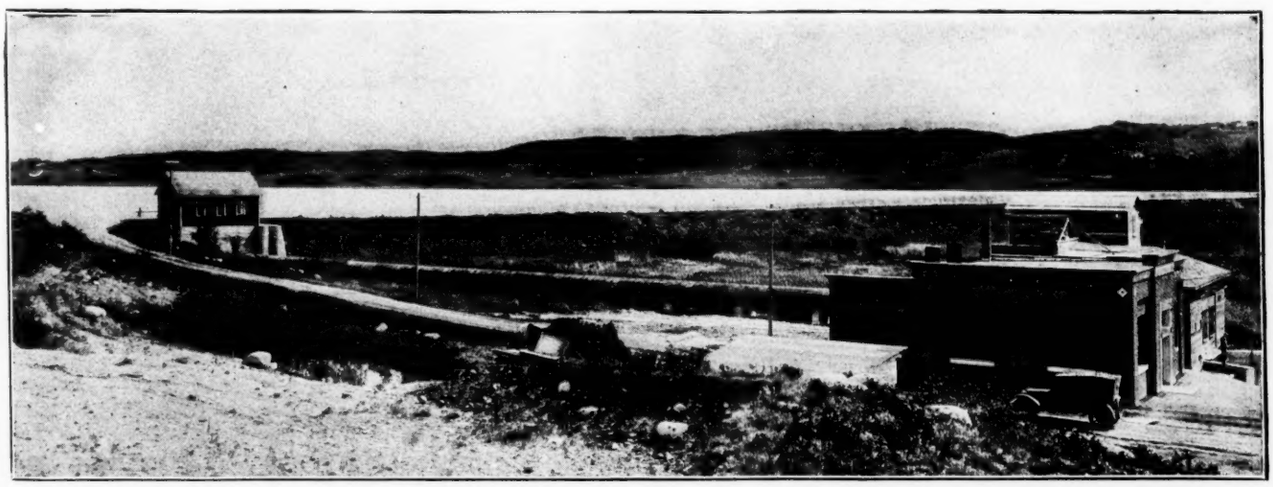


FIG. 2. HYDRO-ELECTRIC PLANT ON THE LITTLE SASKATCHEWAN RIVER, SHOWING EARTH DAM, PENSTOCK, FRAME WHEELHOUSE AND NEW PLANT BUILDING

The plant is completed with an air compressor driver by gasoline engine, fuel-oil pumps driven by electric motor, fuel-oil meter and auxiliary fuel-oil tank. Water for cooling purposes is taken directly from the water reservoir. Circulating water pumps are belt-driven from the mainshaft.

The plant was put in operation in the middle of March, 1921, and has since been in use for continuous 24-hour service while the hydro plant has been in use only a short time. The engines are paralleled every day to take care of the peak load. After each two weeks' run the engine is thoroughly inspected. The operating performances have been found to be up to the test performances.

The average fuel-oil consumption is approximately 0.9 lb. per kilowatt-hour, with fuel having a heat value of 19,000 B.t.u. per pound. For lubrication about five to five and a half gallons of cylinder oil is used per day per engine, and although part of this is recovered it is not re-used on the engines.

Locating Faults in Direct-Current Armatures—Repairing Short-Circuits*

Short-Circuits in Coils and Commutator—How To Locate These Defects by Observation—Different Ways of Cutting Out a Short-Circuited Coil and Making Temporary Repairs

By B. A. BRIGGS

ON ACCOUNT of the low resistance of armature coils a short-circuit in one or more coils cannot be located with a test lamp. As has been explained in previous articles, a short-circuit in a coil may be caused by the insulation failing between two turns in a given coil and allowing the conductors to make a metal-to-metal contact, or by two turns in the same coil becoming ground to the metal core. A group of coils may be short-circuited by two coils being grounded in different parts of the armature. Another frequent cause of short-circuits of armature coils is failure of the insulation between the commutator segments. All these will be manifested by heating of the coil or coils, and where the fault is in the commutator the segments adjacent to the defect will also be heated.

When first starting a machine, if there is a short-circuited coil in the winding it can be located by allowing the machine to run for about a half-minute and shutting it down. Then feel the coils with the hand and it will be found that the defective one has a much higher temperature than the others. The insulating compound on the coil may have started to soften, or it may even have reached a temperature to cause smoking. Care should be exercised in doing this, since the heat produced in the defective coil will soon spread to other coils in proximity. If there is any doubt as to which is the defective coil, the armature should be allowed to cool and the test repeated. Should the coil be burned out, as would be the case if the insulation failed while the machine was in operation, it is easily located by the charred condition of the insulation.

After the defective coil has been found, to repair it will necessitate removing it from the winding and reinsulating it or making a new one. This requires a considerable time and should be done in a repair shop. It may not be convenient to have the machine out of service long enough to make such a repair, therefore if possible some other means must be employed. If the fault is in the coil—for example, say in coil 11, Fig. 1—this coil may be cut in two. It will generally be found most convenient to open the coil at the back end of the armature as at *Y*. In most cases this will create an opening unless the short-circuit involves the two leads from the coil. The next step is to find where the defective coil connects to the commutator. This can be done by starting the machine up and letting it run for a few minutes. The open in the coil will cause arcing on the commutator and produce a burned spot between the two segments to which the faulty coil connects. If the winding is parallel connected, as in Fig. 1, only one burned spot will appear on the commutator, and if series wound, as in Fig. 2, a burned spot will be produced for each pair of poles.

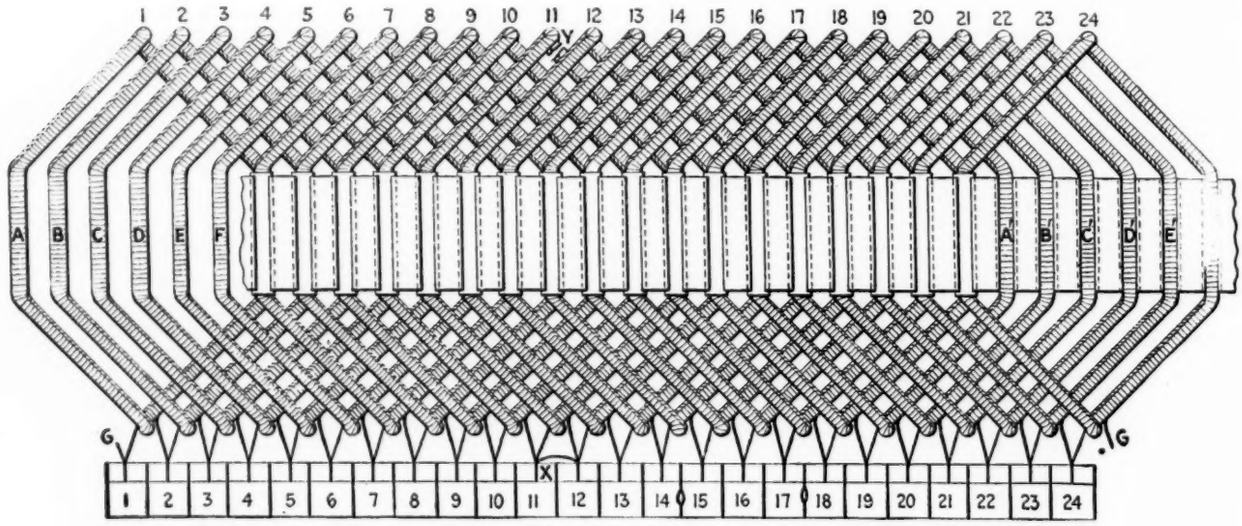


FIG. 1. SINGLE-PARALLEL WINDING, SHOWING HOW TO CUT OUT A SHORT-CIRCUITED COIL

In Fig. 1 the burned spot would occur between segments 11 and 12 and in Fig. 2 two burned spots would be produced, one between segments 4 and 5 and one between segments 17 and 18. By connecting segments 11 and 12 together, in Fig. 1, either by soldering a jumper from one to the other, as shown at *X* in the figure, or by removing a little of the mica from between the two bars at the corner of the commutator, the copper can be swedged across the insulation and the open closed without the use of a soldering iron. This stunt.

*All rights reserved.

although it destroys the coil and leaves a rough corner on two of the commutator segments, has been the means of getting a larger number of machines back into service in a very short time after the repairman arrived on the job. In small machines it may be possible to clean the insulation from the back end of the conductors

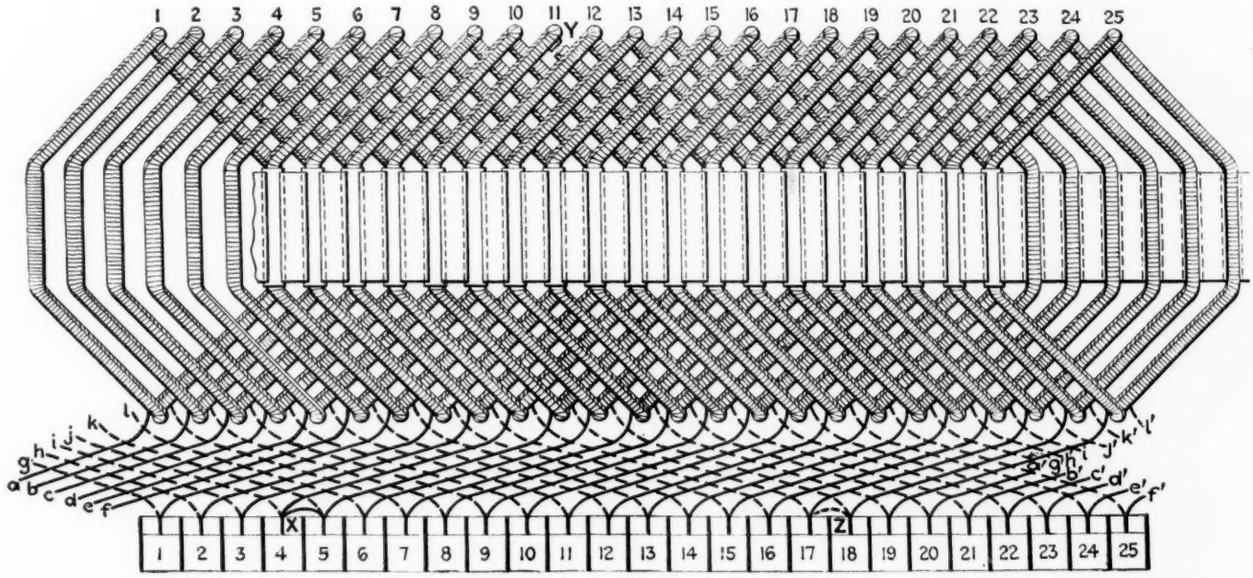


FIG. 2. SINGLE-SERIES WINDING, SHOWING ONE METHOD OF CUTTING OUT A SHORT-CIRCUITED COIL

where the coil is cut in two and twist them together as at *Y* in Fig. 3. This connects the two leads with the conductors at the back end of the coil, so that the circuit in coil 11, Fig. 3, is from segment 12 through lead *a* to the back end of the bottom side of the coil, where it connects to all the conductors in parallel. Then the circuit returns through the bottom side of the coil and around through the top half to the back end again, where connection is made to lead *b*, through which the circuit is completed to segment 11. This is the same as connecting segments 11 and 12 together with a jumper in Fig. 1.

In Fig. 2, connecting either segments 4 and 5 together as shown at *X* or connecting segments 17 and 18, as indicated by the dotted line at *Z*, will close the open-circuit in the winding. However, as explained in the article "Single-Series Winding," in the issue of Nov. 1, 1921, this method of closing an open-circuit in a single-series winding cuts out a good coil also. In Fig. 2 connecting segments 4 and 5 not only bridges coil 11 out of circuit, but also coil 23. In a six-pole machine two good coils would be cut out of circuit, and in an eight-pole, three good coils.

As explained in the article of Nov. 1, the proper thing to do would be to locate the segments to which the defective coil connects and connect these segments

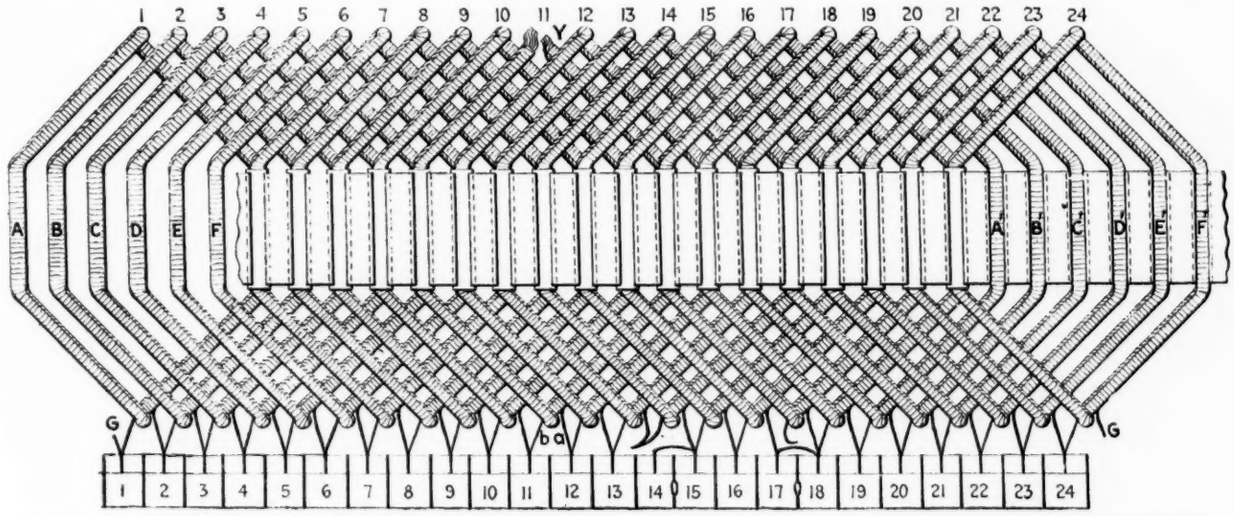


FIG. 3. SINGLE-PARALLEL WINDING, SHOWING HOW TO DEAL WITH SHORT-CIRCUIT IN THE COMMUTATOR

together with a jumper, as in Fig. 4. This jumper takes the place of the faulty coil. Instead of putting in the jumper, if the ends of the conductors are joined together in each half of the coil, where it is cut in two, as at *Y* in the figure, then the coil can be made to act as the jumper. The circuit in Fig. 4 would be from segment 17 around through the bottom half of the coil to *Y*, then back around through the top half to *Y* and back again

through the lead to segment 5, instead of directly from segment 17 to segment 5 through the jumper, if the latter were used. Where the conductors in the two ends of the coil can be connected together, no testing is necessary. The defective coil is located by the heating effect, as explained in the foregoing, then cut in two and the conductors twisted together in each half and the machine put back into service. In many cases it is a matter of only a few minutes' work to get the machine running. The job may not be of the highest quality, but what is lacking in quality is more than made up in speed, which is frequently the all-important factor in getting a machine back into service.

A short-circuit in a commutator will generally be evident by heating of the segments on each side of the defect. Sometimes these segments become so hot as to turn them a bluish color or cause them to rise higher than the rest of the commutators. In many cases it is possible to repair the fault by cleaning out the defective insulation from between segments and filling the cavity with insulating cement. Where this cannot be done, there are two methods of making a repair without removing the commutator and putting in new insulation. First, find the top lead of the coil that connects to the two segments between which the defect exists. Assume in Fig. 1, that the insulation is defective between segments 17 and 18. Since coil 17 connects to these two segments, lift the top lead from segment 17 and connect the two segments together, as in Fig. 3. The end of the coil lead is now insulated and bound down with the rest of the leads. This method cuts a good coil out of the winding and also necessitates locating the coil that connects to the two segments between which the defect exists.

Another method is to lift both coil leads from one of the segments on either side of the defect; it is immaterial which segment. For example, in Fig. 1 assume that the defect is between segment 14 and 15. The two leads may be lifted from either segment 14 or 15, in this case say segment 14. Twist these two leads together and then connect segment 14 to 15 with a jumper, as in Fig. 3. In doing this, the voltage is doubled between segments 13 and 14 and if this insulation is not in good condition between these two segments, the increased potential may cause it to fail in a short time. Assume that each coil has 10 volts generated in it when the machine is in operation, then the voltage tending to cause current to flow from segment 13 to 14 in Fig. 1 is the voltage produced in coil 13, or 10 volts. In Fig. 3 coils 13 and 14 are connected in series and connected to segments 13 and 15, therefore the combined voltage of the two coils exists across the insulation between segments 13 and 14, or 20 volts. As pointed out in the foregoing, this increase in voltage may cause a failure of the insulation between the two segments.

A case in mind is where a short-circuit occurred between two segments of the commutator in which the insulation had deteriorated until it was in very poor condition. The repairman lifted the two leads from one of the segments, twisted them together and connected the bars on each side of the defect, just as the repair is indicated in Fig. 3. After a day or so a defect developed between the two segments to which the two coils in series were connected such as between segments 13 and 14, Fig. 3. Still intent on keeping all the coils in the winding, the repairman lifted the leads from segment 13, twisted them together and joined segments 13 and 14 together. This put three coils in service across the insulation between segments 12 and 13, and in a short period the insulation failed between these two segments, only to have the repairman repeat his former stunt, and to find out that the insulation failed between segments 11 and 12 in a few minutes. After cutting out a few more coils, he sent the armature to the repair shop with a report that the commutator insulation had completely failed. The insulation was undoubtedly oil-soaked and of poor quality, but the repairman was not aware of the fact that he was continually increasing the strain on an already overburdened insulation.

However, this experience is not to be interpreted as being against using the scheme shown at segments 13 and 14, Fig. 3. What it does mean is that judgment must be used, and if the commutator insulation shows signs of not being in good condition, it is best to drop

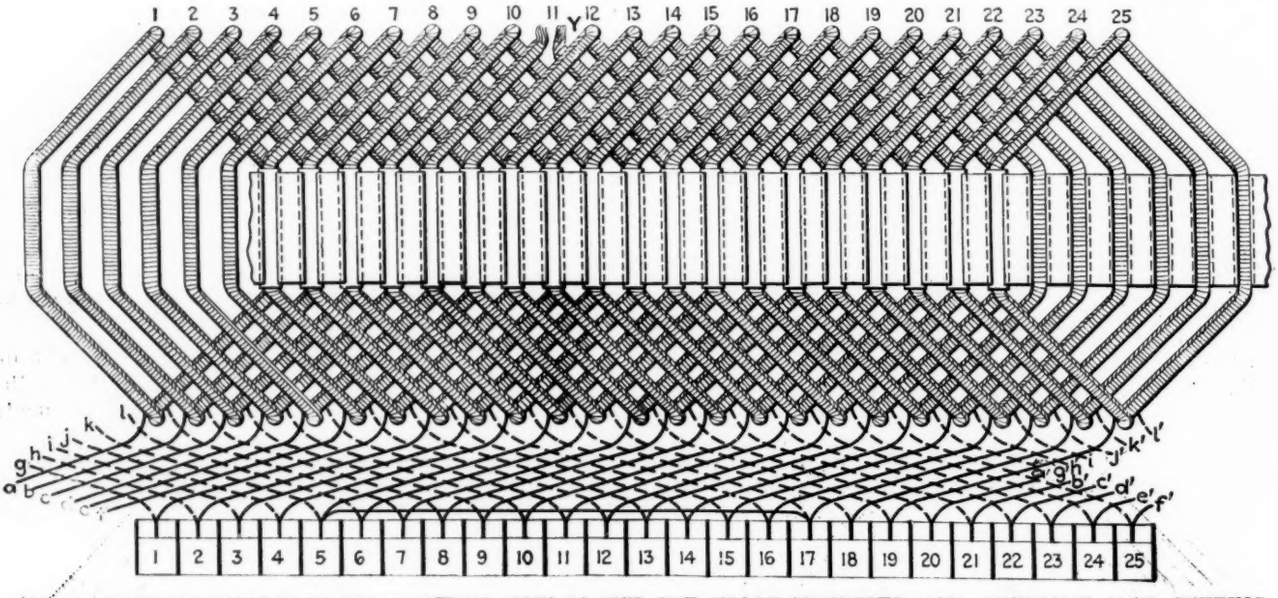


FIG. 4. SINGLE-SERIES WINDING, SHOWING HOW TO CUT OUT SHORT-CIRCUITED COIL, WITHOUT ALSO CUTTING OUT A GOOD COIL AS IS DONE IN FIG. 2

the coil out of the winding, as at segments 17 and 18, under which condition the potential between segments will remain practically the same. If the commutator insulation is good, the method shown in Fig. 3 at segments 13 and 14 may be used, provided the machine does not operate on a voltage above 250. With machines operating around 500 volts or above, the voltage between segments in many cases is high to start with, usually around 15 to 20 volts. If 20 volts is generated in one coil, then two coils in series will produce 40, and this potential is liable to cause a flash-over, even if the insulation between segments does not fail and cause a short-circuit.

It should not be understood from the foregoing that the insulation between segments is capable of standing only a low voltage, since if the mica between segments is clean and in good condition, it will probably stand from 2,000 to 3,000 volts or even higher, before failing. However, in service, after it becomes oil-soaked and the edge at the commutator surface becomes coated with a film of copper and carbon, an entirely different condition exists, and the insulation may not be capable of withstanding 40 to 50 volts or even less continuously without failure.

The next article will tell how to locate defects with a low-reading voltmeter.

Guardian Fuel-Oil Shutoff Regulator

High-and-low-water alarms are safety appliances that are used in most boiler plants to give warning when the water in the boiler is either too low or too high.

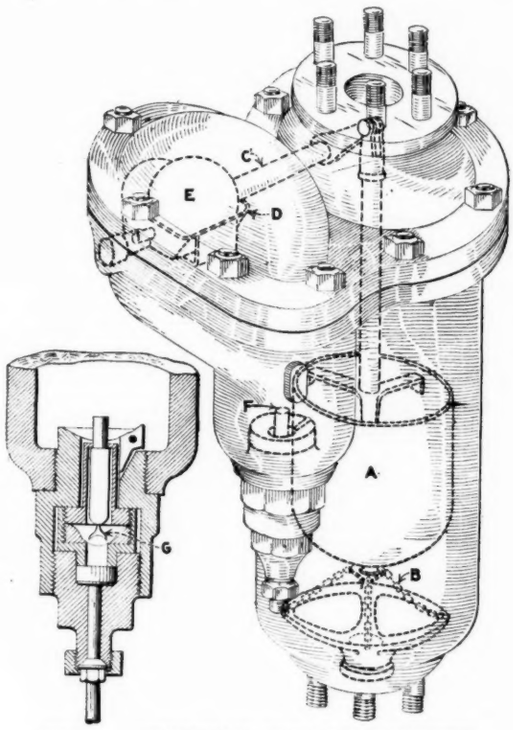


FIG. 1. GUARDIAN FUEL-OIL SHUTOFF

It is equally important to arrange for the automatic regulation of the furnace temperature, in case of low water, when oil is used for fuel. Such a device is found in the "Guardian" fuel-oil regulator, manufactured by the Ronald Trist & Co., Ltd., Dinneford House, 12 Clipstone St., London, W. I., and in the United States and Canada by the White Fuel Oil Engineering Co., 742 East 12th St., New York City, a subsidiary of the Todd Shipyard Corporation, of 25 Broadway, New York City.

This device is designed to shut off the oil supply to a boiler furnace when the water level in the boiler becomes dangerously low. Its action depends on the water level in the boiler, which causes a bucket to fall, and this movement sets a cradle in motion, which permits steam to escape to an oil-supply stop valve. Referring to Fig. 1, the device consists of a cast-iron body having two chambers. In one is a bucket float *A*, anchor and chain suspensions *B*, to prevent the bucket from touching the sides of the chamber. The float is connected to the spindle *C*. The steam connection is at the top and the water at the bottom. The bucket is always full of water, and it balances when four-fifths of its height is immersed in water. When the water level falls in the boiler, it also drops in the float chamber, and the weight of water in the bucket *A* will, at the danger level, produce by its weight a strong downward pull on the spindle and cause the cradle *D* to tip, whereupon the ball *E* falls out and strikes the ram head *F* on top of the cartridge. The ram has a peculiar shaped point (see *G* in sectional drawing) which perforates a copper disc and allows steam to escape through the opening thus made. This steam enters a stop valve, Fig. 2, above the diaphragm, which automatically shuts off the oil fuel supply to the boiler furnace.

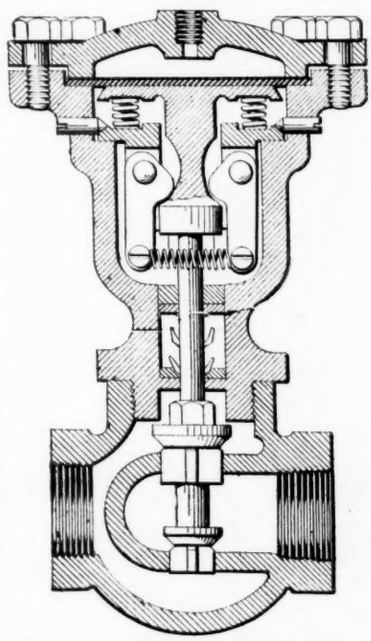


FIG. 2. SECTIONAL VIEW OF OIL STOP VALVE

As the cartridge is a complete unit, it is easily inserted, but not until the ball has been pushed back into the cradle by means of a rod.

Concentrated sulphuric acid is characterized by free dom from odor, has an oily appearance and is heavy in weight. Pure acid is colorless, but in commercial acid there is usually a gray color, due to the presence of organic matter. It is exceedingly hydroscopic; that is, it attracts the moisture from the air and, when exposed, rapidly increases in bulk owing to the absorption of atmospheric moisture. For storage-battery electrolyte, distilled water is used to dilute the acid in order that it may be pure. The greatest care is necessary to maintain all materials used in the manufacture and installation of batteries absolutely pure. Impurities disintegrate the active materials or set up local electrical actions which waste energy and reduce the efficiency of the battery.

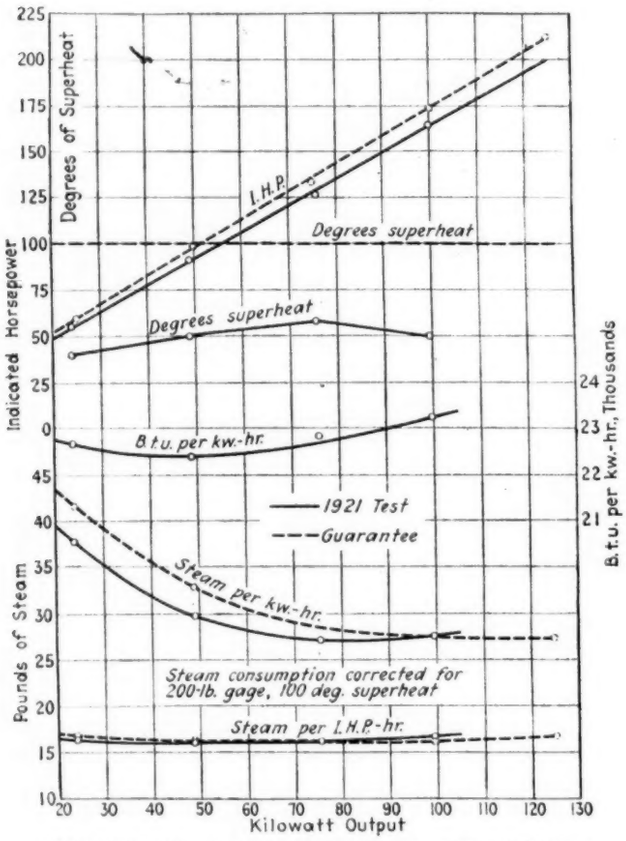
Unaflow-Engine Guarantees and Tests

Universal Unaflow Engine Exceeds Guarantees on Acceptance Tests Made After Four Years of Continuous Operation

By L. A. QUAYLE*

IN THE June, 1916, issue of *Power* a comparison of unaflow engine and turbo-generator operation and fixed charges was made, based on the prices and guarantees of seven different bidders on a 100-kw. generating unit, which was to be purchased for furnishing light and power for Division Avenue Pumping Station and Filter Plant groups of buildings of the Department of Public Utilities, Cleveland.

Curves were shown comparing the water rates of four different makes of turbo-generators and three different



COMPARISON OF GUARANTEE AND TEST RESULTS

makes of unaflow engines, based on an average of the guarantees of the various companies.

As the engine of the bidder submitting the best water rate was purchased, and as the test results were better than the guaranteed, we believe that the unaflow water-rate curves submitted in this article have thus been proved to be conservative. The low guarantees referred to are shown in Table I.

As a result of the comparison of prices and guarantees received on the bids on the unaflow engines and turbo-generators, a Universal Unaflow Engine was purchased and put in operation in July, 1917, and has been in practically continuous 24-hour service ever since.

* Chief Mechanical Engineer, Cleveland (Ohio) Water Department

Although the unit was tested in the shop before shipment in 1917, owing to war conditions and other more important work at the station it was not officially tested

TABLE I. NON-CONDENSING GUARANTEES MADE BY THE SUCCESSFUL BIDDER

Load	¼	½	¾	Full	1¼
Kw. output at 80 per cent power factor	25	50	75	100	125
I.hp.	59	98	134	173	212
Lb. of steam per I.hp., per hour	16.8	16.2	16.2	16.3	16.7
Combined generator and exciter efficiency	75.5	83.2	86.2	87.6	88.0
Lb. of steam per kw.-hr.	41.4	32.8	28.4	27.4	27.7

TABLE II. TESTS OF SKINNER UNIVERSAL UNAFLOW ENGINE AT DIVISION PUMPING STATION, CLEVELAND WATER DEPARTMENT

Test number	1	2	3	4
Date of test	5-20-21	5-20-21	5-23-21	5-23-21
Duration of test, hours	2	2	2	1.5
Engine:				
Barometer, in. hg.	29.44	29.44	29.17	29.29
Steam pressure, lb. gage	199.1	198.7	198.0	198.7
Exhaust pressure, lb. per sq.in.	1.92	2.02	2.24	1.87
Steam temperature, deg. F.	427.0	437.0	445.0	437.0
Superheat, deg. F.	39.5	50.0	57.8	50.3
Speed, r.p.m.	257.0	257.0	256.9	256.6
I.hp. developed	54.9	90.9	126.4	164.4
Generator:				
Generator output, kw.-hr.	23.9	49	75.8	99.5
Power factor, per cent	84.4	80	83.3	87.4
Temp. rise of armature, deg. C.	28.5	31.9	35.1	40.3
Per cent of fuel load rating obtained on test	23.9	49.0	75.9	99.5
Steam per i.hp. per hour, lb.	17.4	16.7	16.9	17.4
Steam per i.hp. per hr., corrected to 200 lb. gage, 100 deg. superheat, lb.	16.3	15.9	16.25	16.6
Steam per i.hp. per hour (guaranteed), lb.	16.8	16.2	16.2	16.3
Steam per kw.-hour, lb.	40.1	31.0	28.1	28.8
Steam per kw.-hr., corrected to 200 lb. gage, 100 deg. superheat, by attached curve, lb.	37.5	29.6	27.1	27.5
Steam per kw.-hr. (guaranteed), lb.	41.4	32.8	28.4	27.4
Combined mechanical efficiency of engine and generator, per cent	59.2	72.8	78.8	81.7
Thermal efficiency of engine, per cent	14.1	14.5	14.3	14.0
Thermal efficiency of engine based on 200 lb. gage, 100 deg. superheat, per cent	15.0	15.3	14.9	14.7
Rankine cycle efficiency, per cent	18.5	18.5	18.5	18.6
Rankine efficiency of engine, per cent	76.1	78.6	77.6	75.4
Rankine efficiency of engine based on 200 lb. gage, 100 deg. superheat, per cent	81.3	82.5	80.6	78.8
Rankine efficiency of engine and generator, per cent	44.4	56.9	62.6	61.05
Rankine efficiency of engine and generator based on 200 lb. gage, 100 deg. superheat, per cent	47.5	59.7	65.0	64.0
B.t.u. per kw.-hr. corrected to 200 lb. gage, 100 deg. superheat, B.t.u.	22,680	22,380	22,830	23,230

The following steam and electrical conditions were specified:

Generator size	100 kw. at 80 per cent power factor
Temperature rise under above load	40 deg. C.
Current	3 phase, 60 cycle, 240 volt
Type of exciter	125 v., 7 kw., mounted at end of generator shaft
Steam pressure at throttle, lb. per sq.in., gage	200
Superheat, deg. F.	100
Back pressure non-condensing, lb. per sq. in., gage	2

UNAFLOW ENGINE AND GENERATOR DATA OF SUCCESSFUL BIDDER

Make of engine	Skinner Universal Unaflow
Bore of cylinder, inches	13
Length of stroke, inches	16
R.p.m. at full load	257
Net weight of engine, complete with flywheels, lb.	28,000
Make of generator	General Electric
Number of poles	28
Voltage of exciter	125
Temp. rise of rotor at 100 kw., 80 per cent P.F., deg. C.	40
Temp. rise of rotor at 125 kw., 80 per cent P.F., deg. C.	55
Temp. rise of field coils at 125 kw., 80 per cent P.F., deg. C.	55

and accepted after its installation in the Division Avenue Station until October, 1921, or after over four years of continuous service.

The results of the tests at from one-quarter to full

load are given in detail in Table II, and the more important data are plotted on the curves, Fig. 1.

The valve setting was checked and the valves were tested for tightness before the acceptance test was run, but no grinding was found necessary, as the four valves were steamtight, although they had been given but one light grinding since the engine was put in service. The cylinder head was also removed for the first time, but the cylinder bore appeared to be perfect, and the piston was steamtight, so the head was immediately replaced and the test started.

We believe it is rather unusual for an engine to be tested after four years of continuous service with no other work done on the engine than the adjusting of valve settings and testing the piston and valves for tightness, before the tests are run, and still have the engine meet the guarantees made for it.

Condensing tests were also run, but due to short-circuiting of the circulating water in the condenser, which had not been used for several months, only a low vacuum was obtainable, and for this reason another set of condensing tests will be run after the condenser has been overhauled, and published later.

Wilmon Vacuum Trap

The Wilmon vacuum trap, with the exception of the cover bolts, has but thirteen parts, and by removing eight tap bolts, the working mechanism, mounted on a flange, can be taken out as a unit. A compound pressure gage and a sight glass give a double check on the operation of the trap. Where a permanent record of operation is desired, a recording gage with electrical contacts may be added.

The receiving chamber of the trap, Fig. 1, is under vacuum while the water is collecting in the trap and

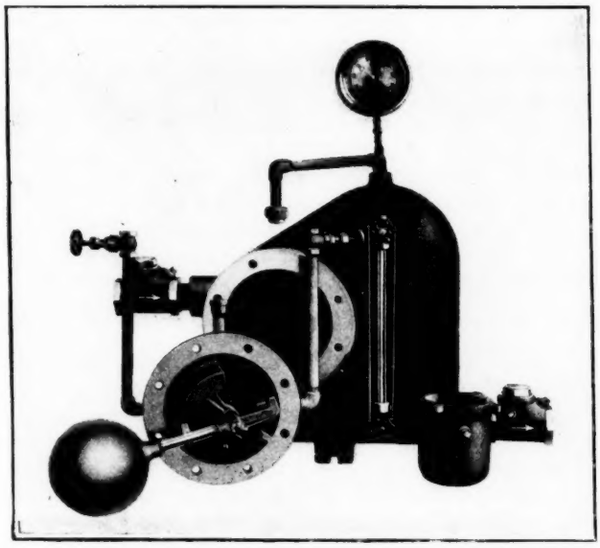


FIG. 1. TRAP WITH COVER AND FLOAT MECHANISM REMOVED

under atmospheric pressure during discharge. Back flow is prevented by check valves on the inlet and outlet lines Change of pressure in the receiving chamber from vaccum to atmospheric and vice versa, is accomplished by an oscillating disc covering three ports, Fig 2, which makes a quick shift from one operating position to the other. One of these positions connects the receiving chamber with the vacuum system, and the other connects the chamber with the atmospheric line, the communication being effected in both instances through the equalizing line which connects the middle port to a top opening in the receiving chamber.

The disc and thrust bearing and the spring that holds these parts in place are in a separate outer chamber, where they are never in contact with the liquid within the receiving chamber. The disc is operated by a lever

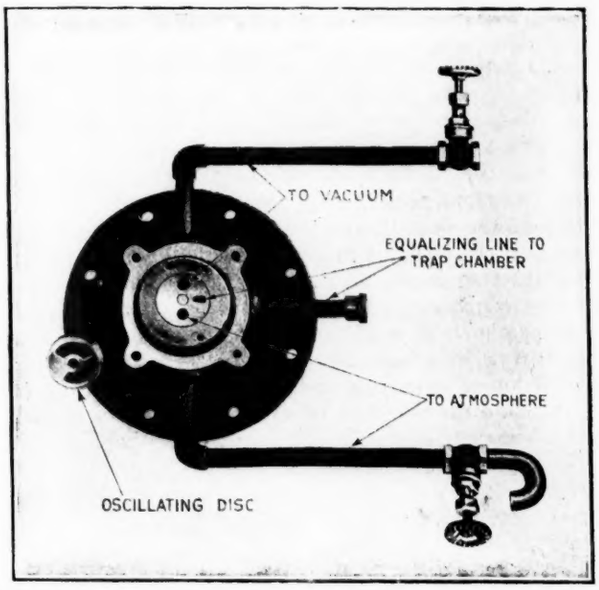


FIG. 2. DISC AND SEAT, SHOWING THE CONTROLLING PARTS

float, hammer weight and rocker arm, all on the same shaft and within the receiving chamber.

Water entering the receiving chamber carries the float upward as the level rises, and a contact point on the float stem, between the float and its fulcrum, rotates the weight until, as the latter passes the dead center, it drops on the contact point on the rocker arm and partly rotates the oscillating disc to the opposite position. This shuts off the vacuum line and opens the receiving chamber to atmospheric pressure through the atmospheric and equalizing lines. Water is then forced through the trap outlet, if the latter is connected to a vacuum, or drains by gravity if connected to atmosphere. As the float falls with the water level, the contact point beyond the fulcrum on the float stem lifts the weight past the dead center and lets it drop in the opposite direction, when it hits the opposite end of the rocker arm and shifts the disc. This cuts off the atmospheric line, connects the vacuum and equalizing lines and brings the receiving chamber under vacuum again. The cycle repeats at a rate determined by the amount of water accumulating. The disc requires no adjustment either before trap installation or during service, but may be seen and reached while the trap is in operation.

The absence of liquids at the controlling ports permits salty or alkaline water to be handled without fear of salting or eroding the operating mechanism.

The capacity of the trap, which is manufactured by P. H. Gill & Sons Forge and Machine Works, Brooklyn, N Y., is limited only by the size of the inlet and outlet openings. The 2-in. trap, for instance, handles 1,800 to 2,100 gal. of water per hour. This capacity will vary, depending on the lift of the discharge.

Overhauling a Refrigerating Plant

A Discussion of Where To Look for Leaks and the Correct Way of Making the Repairs

By L. C. MILLER

DURING the idle period in the winter the engineer in charge of refrigerating equipment should seize the opportunity to secure thorough going over of the entire plant wherever he has any idea that possible trouble will appear during the heavy-load period in the summer season. Every part of the equipment should be so cleaned, adjusted and inspected and repaired that the highest possible capacity can be obtained in a pinch and that the highest operating efficiency can be had when the plant is properly loaded.

One of the first things that should be attended to is the leaks. During the present season I know of at least one plant that neglected to pay attention to this detail, and as a consequence they had to charge about 2,000 lb. of ammonia into a 250-ton system during the year. Last spring they laughed at the idea that leaks would allow a lot of ammonia to be lost, but today they are only waiting for the time when they shut down to make the necessary repairs.

The majority of the leaks are in the discharge lines, the compressor piston-rod stuffing boxes and in the condenser, particularly if of the double-pipe type. The discharge lines and the condenser are more liable to spring leaks because of the widely fluctuating temperatures to which they are subject, sometimes changing from one to two hundred degrees in a short time when the system has been pumped down and someone opens the expansion valves too wide when the system is started again. They are also subject to high pressure, which is another reason why they spring leaks.

Condenser Gaskets

Personally, I am not much in favor of lead gaskets in ammonia discharge lines or the top pipe joints in a condenser. In the lower pipe joints of the condenser lead gaskets apparently work out pretty well, but even there I prefer any of the many asbestos sheet packings. Lead is practically dead, or non-elastic, while asbestos sheet will come and go with the expansion and contraction of the pipe and joint. Furthermore, if a lead-gasketed joint begins to blow under high pressure and with hot gas passing through the line, it is only a short time before the action of the hot gas blowing through the leak will cut the lead gasket through. The only thing to do when this happens is to put in a new gasket, which means a serious loss of time during the time when the maximum load is on the plant. The asbestos sheet gasket, on the other hand, can blow for any length of time, and if the bolts are drawn up again on the joint it is as good as ever. Consequently, I would advise the engineer to pull out the old lead gaskets and put in asbestos-sheet or rubber-composition sheet gaskets.

When it comes to the individual stands of the condenser, I would not be so positive. Everything from the compressor up to the valve on each individual stand of the condenser, however, should be made up with a reliable gasket in every joint. If anything goes wrong with one of the individual condenser stands, it is a simple matter to shut it off and pump it out and repair the job without interfering with the regular operation of the system. If a gasket blows between the compressor and the individual valves to the stands, the whole condenser must be cut out to make repair. For this reason I always make very sure of the gaskets of every joint in this section.

Repairing Valves

If you have been having trouble with any of the valves on the individual condenser stands leaking, this is the time to take them out and grind them in. For that matter the whole set of valves on the condenser should be tested. It is quite a simple matter to pump out the whole condenser and close every valve. High-pressure gas should then be turned into the header and the purge valves on the individual stands opened, one at a time, and if any one of the valves is leaking, it will not take the engineer long to discover the defect.

If the condenser is of the double-pipe type, every bolt should be gone over and drawn up tight. If there is any doubt about a nut drawing up freely, take it out and put in a new bolt and nut that works freely. If a leak then starts at any time during the summer season, you have a good chance of stopping it again by pulling up on the nuts.

If the rubber rings, which are generally provided for the joint between the water and ammonia pipes, have been in place for a number of years, the safest policy and generally the most economical in the long run is to remove the old ones in the entire condenser and put in new ones. I have known these to stay in place without a leak for five or six years, and sometimes longer, while others go to pieces before being used more than two years or so.

The connections to the liquid header of the condenser, the liquid valves and the liquid line joints as a general rule do not give anything like the trouble that the gas lines and the gas sections of the condenser do. It is seldom that a leak starts in these connections, and as a general rule, the liquid valves of a condenser will shut off tight regularly while the gas valves are likely to leak.

Leaks in Water Connections

The water pipes in double-pipe condensers should be investigated for leaks. These sometimes split or corrode through, and a large quantity of ammonia will escape into the condensing water without being noticed, particularly if a cooling tower is used. Testing a double-pipe condenser for leaks of this kind is quite a simple matter. Drain the water out of every stand and let it stand until the coils are thoroughly dry on the inside.

When ready for the test, the top or bottom cock on each side should be closed. It makes no particular difference which end is shut off, but the top is generally more convenient to test and should be left open. A pressure of about 200 lb. should now be pumped upon the condenser, and after holding this pressure for an hour or so, the engineer should pass a lighted sulphur stick across the open end of each coil. If there are any leaks worth mentioning, it will not take long to find them. If a leak is found in any stand, it will then be necessary to

remove the water return bends on each end of this stand, whereupon each pipe in the stand can be tested independently and the defective pipe easily located.

Compressor Leaks

Leaks at the compressor or stuffing boxes may be due to any one of three causes. They may be caused by a worn or scored rod, in which case the rod jams at the end of every stroke and runs entirely too loose at the center, and as a consequence the gas blows through. They may be caused by too loose or improperly adjusted crosshead shoes, throwing the rod out of line and causing it to travel from one side to the other in the stuffing box, in which case the very best packing will not hold it tight for any length of time. Finally, the leak may be caused by the fact that the rod has been turned a number of times without placing a junk ring, or, as it is sometimes called, a neck ring in the bottom of the stuffing box. If this is not done, the bottom ring of packing will squeeze through between the rod and the neck of the stuffing box, jamming the rod and causing it to run hot and burn the packing, and finally a large proportion of the packing will be forced out through this space. The packing will not only be ruined, but the rod as well, since burnt packing is more or less abrasive.

The junk ring should be made so that it is a snug fit on the rod and fits easily in the stuffing box. If the rod is a little low, as it may be in a number of horizontal machines that have been run for any length of time without having the cylinders rebored, making this junk ring with a loose fit in the stuffing box permits of a little shifting in the stuffing box, enabling the ring to accommodate itself to the line-up of the rod. If the ring is made a snug fit on the piston rod and also a snug fit in the stuffing box, it will be readily seen that it would begin to cut the rod if the latter be ever so slightly out of line.

While on the subject of leaks it may be well to mention the compressor piston and valves. While these have no bearing on the ammonia waste, they may actually cost in dollars and cents more than the ammonia lost at various leaks. In other words, if the piston and valves of the compressor leak so badly that while operating the machine at full speed you get only half capacity out of it, you may be paying as much for power as if you were getting full capacity out of it. I have seen a number of plants where this condition existed, and any number of others where the waste from leaking pistons and valves was from 20 to 30 per cent.

Testing the Valves for Tightness

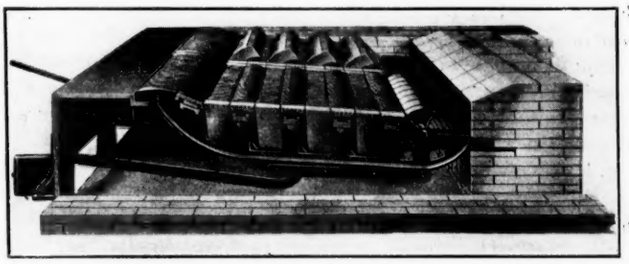
As many as possible of the stop valves on the system should be tested for tightness, particularly those in the discharge lines at the condenser, the suction and discharge stop valves at the compressor or generator and absorber of the absorption system, and any valve that controls the flow to any important unit or section of the system. The time spent in testing these valves during the overhauling period will be repaid many times over.

In order to make sure that the valves will operate freely, put in new packing on the valve stems and grease the stems of all valves that are used quite often. Those that are used only once in a long while should be painted with white lead or some kind of paint that will not peel off or be affected by the ammonia fumes; graphite paint does very well for this purpose, and when you have to close the valves they will spin shut as easily as the first time they were installed.

Another matter that should be looked after is that of insulation, both of the pipe lines and other equipment. If the insulation is allowed to become loose so that moisture gets under it and next to the pipe, the latter will cause the entire insulation to peel, particularly if it is made of cork. Pipe lines and other equipment that carry low-temperature gas or liquid, including the brine lines and coolers, should be well insulated if the maximum capacity and economy of the system is aimed at. Very often a thorough insulation of the entire equipment where the refrigerating is done will increase the capacity of the system 10 to 20 per cent. The latter figure is rather extreme, but there are a number of cases in my experience where this has been done in special cases.

The Auburn Hand Stoker

A new hand stoker requiring little incline for its successful operation, and therefore no excavation for the ashpit, has been perfected recently by the Marion Foundry Corporation, of Auburn, Ind. The illustration shows the stoker installed in an ordinary furnace with a 24-in. ashpit. A slight incline of 8 deg. has been given to the grate surface to gain space between the fuel bed and the boiler shell.



SHOWING THE GENERAL DESIGN OF THE STOKER

Reference to the cut will show that the stoker is made up of a curved coking plate at the front, alternate moving and stationary elements in the grate proper and a cutoff dump plate at the rear. The stoker is divided into two longitudinal sections, and the cross elements are locked into the side frames in such a way that any individual part of the surface can be replaced.

Coal is piled up on the curved coking plate and is carried back toward the rear of the furnace by the moving elements, or stoking units of the grate. One full movement of these units pushes the entire fuel bed six inches to the rear. The illustration shows the stoking elements in one longitudinal section of the grate advanced to one-half of the full stoke. With so large a movement oscillation of the operating lever need not be frequent, so that the labor of stoking, and "droppage" of the unburned fuel into the ashpit are minimized. A separate lever at the furnace front operates the dump plate. All moving elements are counterbalanced to make operation easy.

Air spaces of $\frac{1}{4}$, $\frac{3}{8}$ or $\frac{1}{2}$ in. are provided in the grate surface. The weight approximates about 110 lb. per square foot of top surface.

"Electric-light plants are said to grow from bulbs," remarks *Life*. Again the old question, Which comes first, the hen or the egg?

Lubrication—Refining Petroleum

By W. F. OSBORNE
Supervisor Manufacturers Service, Texas Company

SINCE crude petroleum consists of a mixture of hydrocarbons, each of which has a definite boiling point, the easiest way to separate them into commercial products is to evaporate the petroleum and condense the vapor.

When a still, consisting of a horizontal cylindrical shell with a fire underneath, is filled with oil and heat applied, that portion of the oil which has the lowest boiling temperature is driven off first. The hydrocarbon with the next higher boiling point goes off next, and so on until all are evaporated. Following the general laws governing the evaporation of mixtures of liquids, some of the heavier compounds will be evaporated with the lighter ones, and some of the lighter compounds will remain in the still with the heavier.

Fractional Condensation

There are two ways of distilling petroleum. In one system the still is filled with crude oil and the heat regulated so as to evaporate the oil completely, leaving in the still nothing but a coke residue. The various products are separated by passing the vapor through a series of condensers, the temperature in each condenser being lower than that in the preceding one. The products with the highest boiling points are condensed in the first, or high-temperature, part of the condenser system, and as lower temperatures are reached in the progress of the vapor through the condensers, hydrocarbons with lower boiling points will condense, until finally the lowest practical temperature is reached at which nothing remains in the pipes but uncondensable gas. The products collected at the different parts of the condensers are drained to tanks and are known as distillates. They are further redistilled and refined until their properties meet the marketing requirements. This process is termed *fractional condensation* of the vapor.

Continuous Distillation

In the second process the oil is pumped continuously through a series of stills in each of which the oil is heated to a slightly higher temperature than in the previous one. The vapor from the first still is evaporated at a low temperature and is carried off from the top of the still and condensed in a series of condensers which still further divide the oil, as previously explained. The next still through which the liquid oil is pumped is maintained at a higher temperature, and vapor of a higher boiling point is collected. This process continues through as many stills as are required to produce the desired number of grades or distillates. This process is called *continuous distillation* and is based on the principle of fractional distillation and fractional condensation.

The oil in the still is heated in some instances by a fire directly underneath the still. In other cases live steam is introduced into the still to agitate the oil and secure satisfactory evaporation at a lower maximum temperature than can be secured with the direct fire alone. The use of steam is particularly desirable in the refining of lubricating oils, as it renders unnecessary the high temperatures which cause cracking and decomposition of the petroleum.

In both of the processes mentioned, as well as in many other variations of the general principles, the first distillates are not suitable for the market and it is necessary to redistill one or more times until the distillates contain hydrocarbons with a sufficiently narrow range of boiling points. The distillates vary with the crude and the character of the finished product desired, but in a complete plant for the manufacture of gasoline and lubricating oils, the distillates in order of their boiling temperatures would be for paraffin crude oil somewhat as follows: Naphtha distillates for gasoline; burning-oil distillates for kerosene, and similar grades; gas oil or solar oil; wax distillates for paraffin wax and lubricating oils.

From certain grades of paraffin crudes the residue remaining in the still will be steam-cylinder stock. For naphthene crudes the products would be: Naphtha distillate for gasoline; burning-oil distillates for kerosene, etc.; gas oil or solar oil; lubricating distillates, and the residue in the still would be liquid asphalt.

After the distillates are secured, each is specially treated and refined in order to meet the requirements of the service for which it is intended. Lubricating distillates are first separated by further distillation into oils of the various viscosities necessary, in this manner giving us the light, medium, heavy and extra-heavy oils as may be desired. Each grade is then treated with sulphuric acid to remove any undesirable compounds which might be contained in the distillate, and afterward washed thoroughly with water, neutralized with caustic soda and again washed to remove any trace of alkali.

Filtration

If a pale-colored oil is required, the color may be secured by further acid treatment, sun bleaching or filtration. The acid method results in a considerable loss and requires further neutralizing and washing. The filtration process consists of filtering the oil through fullers earth, which removes any undesirable compounds that might cause emulsions or excessive carbon deposits if allowed to remain in the oil.

When certain paraffin crudes are distilled with steam, the residue remaining in the still is heavy in body and possesses the properties necessary for steam-cylinder lubrication. This steam-cylinder stock may also be filtered, the process giving a clear bright-red oil with a dark-green bloom, quite different in appearance from the opaque-green color of the familiar steam-cylinder oils.

After the oils are fully refined, they may be blended to secure the desired viscosities, when grades differing from the viscosities of the natural distillates are required. Naphthene-base oils are made by straight distillation methods in a range of viscosities from 65 to 1,000 seconds Saybolt at 100 deg. F. Paraffin-base oils in general, when secured from straight cuts, range from 50 to about 325 seconds Saybolt. When heavier-bodied paraffin lubricating oils are required, they are made by adding filtered cylinder stock to the light-viscosity distillates, thus raising the viscosity to the desired point. This blending process gives these oils the familiar greenish tinge, or bloom.

The Detection of Errors in the Steam-Engine Indicator

An indicator is of no benefit if it does not give a diagram free from serious errors. This article, the third of the series, deals with the most probable of these errors.

IN PURCHASING and using an indicator, there are several important factors that must be considered. If the diagrams are to be truly representative of the cylinder events, the workmanship of the instrument must be of a high grade; the pencil motion must bear, at all points, the same ratio of vertical pencil travel to travel of the indicator piston; the materials and design must be such that distortions due to temperature changes do not alter the instrument's accuracy; the parts must either be subject to little wear or be susceptible to adjustment if wear does occur, they must be as light as is consistent with strength in order to avoid undue inertia effect, and the friction of the several parts must be reduced to a minimum.

The cylinder barrel and piston should be lapped to fit master gages, in order that parts broken or worn in service may be replaced by duplicate parts. The piston need not have an exceedingly close fit in the cylinder, for a slight leakage around the piston will not affect the action provided the connection to the engine cylinder is full and free. As long as a large supply of steam is available, no pressure drop will occur even though the

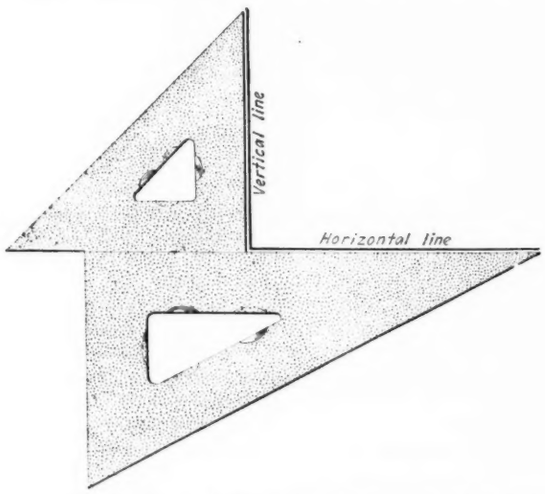


FIG. 1. CHECKING ALIGNMENT OF DRUM AND PISTON

piston fit quite loosely. The manufacturers usually provide a clearance of from 0.00015 to 0.00025 in. The area of the piston is fixed precisely as that to which the springs are sealed, usually 0.5 sq.in. The chief requisite is that both the piston and cylinder be true to avoid binding at any point.

The pencil motion must be rigid to prevent whipping due to high speed and at the same time must be light to avoid inertia effect. As a consequence the several parts are usually made of tool steel.

The line along which the pencil point moves should be parallel to the axis of the paper drum in order that the vertical motion of the pencil may be at right angles to the horizontal travel of the paper. If the motion is true, the pencil will bear equally at all points along its line of travel. To check this, the piston spring may be removed and the pencil-adjusting screw turned until when it strikes the post the pencil point just misses

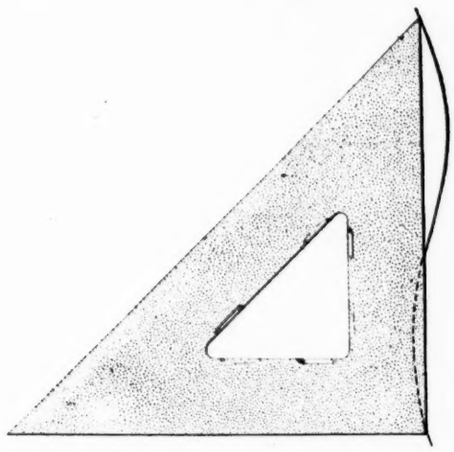


FIG. 2. DETECTION OF ERROR IN PENCIL PARALLELISM

touching the paper. Upon pushing the piston upward, provided the pencil motion is not bent or out of square with the drum axis, the pencil point will move up along the drum at the same distance from the paper.

Of equal importance is the correctness of the vertical pencil travel in relation to the horizontal travel of the drum. The pencil should be lightly brought against the drum paper and the piston pushed upward, causing the pencil to make a vertical line. The drum cord should be next pulled and a horizontal pencil mark drawn. The paper should then be removed and the angle made by these two lines checked by triangles as shown in Fig. 1. If the two lines are not at right angles, it may be inferred that the pencil motion is not accurate or that the drum axis is not parallel to the cylinder axis.

The pencil motion must also give a straight vertical line and not the curve which will result if the pencil motion is not correct. This is difficult to check since the pencil travel cannot exceed the drum height and the departure from a straight line is small in a two-inch range. If the error is serious, it will show up if a straight-edge is placed alongside the line drawn by the pencil. This is shown exaggerated in Fig. 2.

The pencil travel should at all times be proportionate to the piston travel. Frequently, the pencil motion shows a varying ratio at the upper and lower limits. If a depth gage be inserted into the indicator cylinder and the piston held in contact with the gage end, Fig. 3, any number of equal portions of the piston travel may be secured and a mark made by the pencil at each of the new positions. If the pencil motion is accurate, the distance between the pencil marks will be equal for equal movements of the piston.

If any discrepancy exists in the spacing, the indicator pencil motion is inaccurate, due either to the design or to wear at the joints.

The working barrel, if of unequal thickness, may not expand equally at all points. The piston will then bind. This cannot be detected while the instrument is cold. In all the modern indicators the barrel is held at one end only and distortion seldom occurs. When the indicator cock is first opened, the barrel may be slightly warped until its temperature becomes uniform.

The rapidity with which the indicator piston and pencil motion works will, if the weights of the parts are excessive, give rise to inertia effects which may cause serious distortions on the diagram. It follows that the higher the speed the lighter must the parts be. Indicators that were satisfactory on engines running at 70 r.p.m. will not give accurate diagrams at 300 r.p.m. The several indicators now manufactured have the parts as light as consistent with strength, although there is

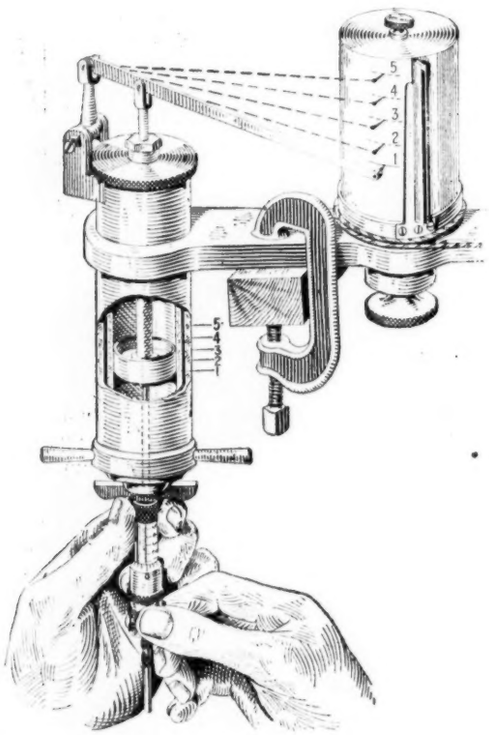


FIG. 3. TESTING ACCURACY OF PENCIL TRAVEL

some difference in the weights of the parts as made by the several manufacturers.

The indicator that has a considerable amount of friction will not give a reliable diagram. To detect excessive friction, the piston without the spring should be placed in the indicator and the pencil motion attached. By raising and lowering the pencil arm by the fingers, any decided friction will be felt by the resistance to the travel of the piston. After raising the piston and pencil lever to the limit of their travel, the thumb should be placed over the indicator opening, Fig. 4. When the pencil lever is released, the parts should settle very slowly, but should drop sharply when the thumb is removed. This should be done after the indicator has been thoroughly warmed to place it in the condition existing when in use.

Seldom do new indicators show lost motion at the bearing pins. After continual use these pins will wear, and if adjustment is not made, the diagrams secured are of little use. To detect wear, place a strong spring in the indicator to prevent movement of the piston and then, by pressing and lifting the pencil lever, any lost motion will show up. The wear is usually in the connection of the swivel head to the piston and in the pencil-motion bearing pins. In many indicators the lost motion can be taken up by tightening up the pins.

With inside-spring indicators high steam temperatures often alter the spring characteristics and give erroneous pressure values. With the outside spring

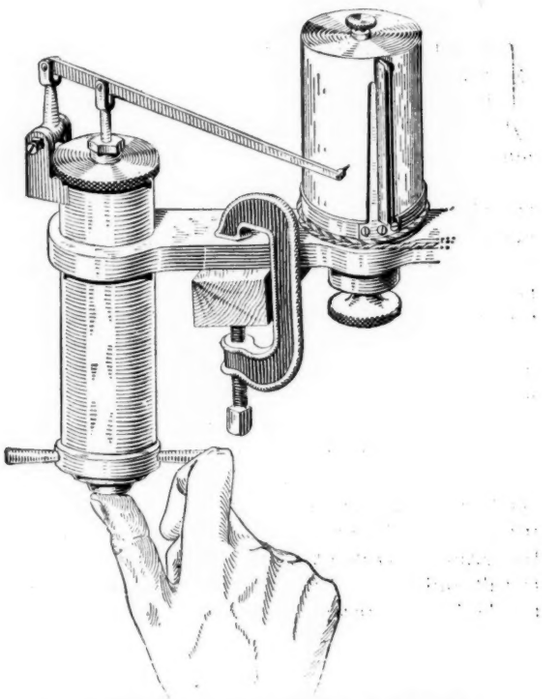


FIG. 4. FREEDOM FROM PISTON STICKING

this condition does not exist and spring error is not so common. To test the accuracy of the spring, the indicator should be attached to a dead-weight testing set. The hydraulic pressure should be raised to any desired value, say 80 lb., and a line made on the drum paper with the pencil point. The pressure is next raised to, say, 90 lb. and a second line made on the paper. This is followed to the maximum pressure desired. The action should now be reversed and the pressure dropped to the successive values used before in the reverse order. If the lines as made at each pressure while increasing and decreasing the pressure are as close together as in Fig. 5, no serious error in the diagram will exist. If the discrepancy is larger, the spring is not true and should be replaced.

With small engines an error of one or two pounds in the pressure reading is not serious, but with large cylinders an error of one pound would involve a serious error in the computation of the apparent horsepower developed. For example, in a 48 x 60 engine running 80 r.p.m., with steam at 150 lb. pressure, an error of 2 lb. in the indicator spring will show an error of 87 indicated-horsepower.

Some indicators have a heavy bushing into which the pencil lead is inserted. The inertia of this weight may cause the pencil lever to whip, producing a distorted

diagram. Others have the pencil lever flattened, forming a light split sleeve into which the pencil lead slides. This design is much lighter and is considered by many as more satisfactory than the other.

The length of the indicator diagram is limited by the diameter of the drum. While for slow-speed machines long diagrams that are accurate may be secured, with modern engines of higher speeds a smaller drum or diagram is desirable. With long diagrams the drum must travel at a high rate of speed and the pencil does not follow its true path, owing to the draft of the

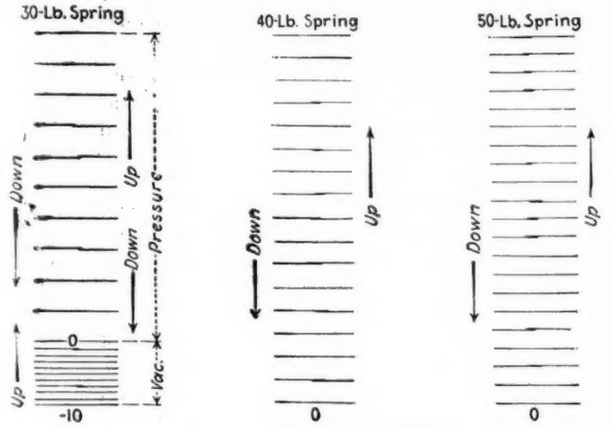


FIG. 5. SPRING ERROR

high-speed drum. Furthermore, on a short diagram the points of cutoff and release are sharper than in a long diagram. For these reasons the drum should not exceed 2 in. in diameter and the diagram length might well be made 3½ in. or less.

Using the Eye as a Pyrometer

When a solid body becomes sufficiently hot to glow with its own heat, the color that it emits depends on the temperature and is practically independent of the nature of the material. That is to say, a piece of steel at 2,000 deg. F. will have practically the same color and brightness as a piece of firebrick at the same temperature. For this reason the eye may be used as a pyrometer within the limits imposed by individual variations in judgment of color and keenness of vision. The method has many practical applications.

The following table represents the average in round numbers of the temperatures corresponding to various colors as given by a number of authorities:

Color	Approximate Temperature, Deg. F.
Lowest red visible in the dark	800
Lowest red visible in twilight	900
Lowest red visible in daylight	950
Dull red	1,100
Full cherry red	1,300
Light red	1,600
Orange	1,700
Full yellow	1,800
Light yellow	2,000
White	2,200
Brilliant white	2,600
Dazzling (bluish) white	2,800

Where the temperature is too low for the material to glow, it is sometimes possible to estimate it by placing a polished piece of steel at a point where it can come approximately to the temperature that is to be determined. Upon removal the steel will be found to have a "temper" color corresponding to the highest temperature attained by it. These colors for various temperatures are given in the following table, which, of course, can be used only between 430 and 600 degrees:

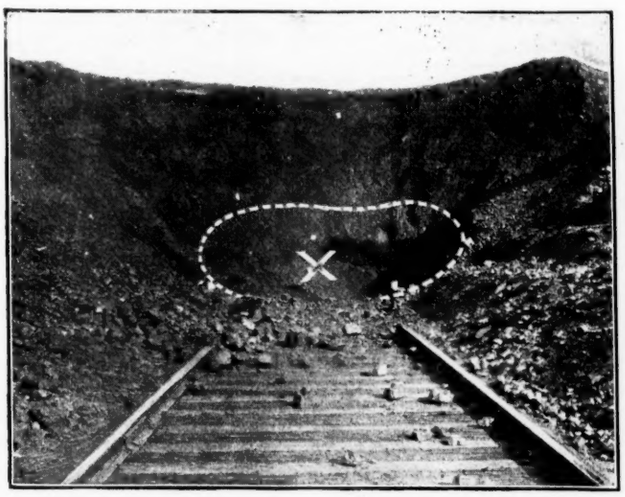
Temperature, Deg. F.	Colors	Temperature, Deg. F.	Colors
430	Very pale yellow	510	Spotted red-brown
440	Light yellow	520	Brown purple
450	Pale straw yellow	530	Light purple
460	Straw yellow	540	Full purple
470	Deep straw yellow	550	Dark purple
480	Dark yellow	560	Full blue
490	Yellow brown	570	Dark blue
500	Brown yellow	600	Very dark blue

Another method of determining temperatures is by the melting points of various substances. A few convenient melting points are given in the following table covering a range of 2,700 degrees:

Substance	Melting Point, Deg. F.	Substance	Melting Point, Deg. F.
Ice	32	Zinc	786
Tallow	92	Aluminum	1,214
Wax	142 to 154	Copper	1,943
Tin	449	Cast iron (gray)	2,230 (approx.)
Lead	620	Wrought iron	2,740

One Method of Handling Fires in Stored Coal*

In the Bridgeport (Conn.) plant of the United Illuminating Company the coal-storage space is limited, so that in order to keep on hand from 14,000 to 16,000 tons of coal, it is necessary to pile the coal to a depth of 22 ft. This is considerably above the safe depth if spontaneous combustion is to be prevented. Fires have been of frequent occurrence, but have never resulted in serious trouble or loss since all parts of the pile can be quickly reached by a locomotive crane which handles all the coal.



THE DOTTED LINE SHOWS THE EXTENT OF THE FIRE

The fires have invariably started at a point about four feet from the ground, and a few feet from the edge of the pile. The method of handling the fire has been to dig out the burning coal with the crane and spread it on the ground, in a corner of the yard, where it is quenched with a stream of water.

The figure shows a part of the coal pile where a fire had been dug out a few minutes before. The dotted line indicates the extent of the excavation, while the *X* shows where the fire started

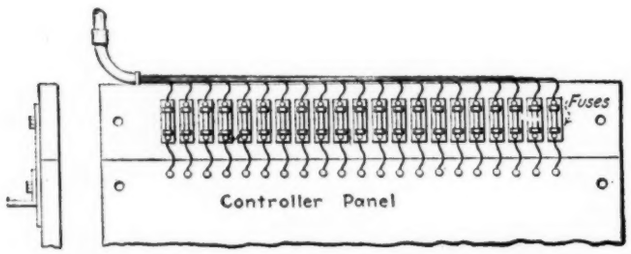
*Information supplied by Oscar J. Richmond, chief engineer of the Bridgeport plant of the United Illuminating Company.

Elevator Maintenance Plan and Preventing Troubles in Exposed Locations

By J. E. HOUSLEY

ELEVATORS which are found in industrial plants are often exposed to the elements where the nature of the manufacturing program does not accommodate the elevators and skip hoists in the interior of the plant buildings. The greatest number of interruptions with such elevators has been found to be caused by the control wiring, as might be surmised from the fact that the limit switches and control stations are exposed to the atmosphere. A means of lessening the delay from this cause was developed, and by special wiring methods trouble due to insulation breakdown was minimized.

The most satisfactory plan of maintenance involves the daily inspection of all the control boards by a designated workman who is held responsible for all preventable failures of contacts, relays and commutators. During the routine inspection the contacts are cleaned and all bolts and clamps are maintained tight without the equipment being taken out of service. Where major replacements are made or guides oiled and cables inspected, a time is selected by consultation with the production foreman so as to cause the minimum disturbance to the production schedule, which is continuous. The control board is seldom located where it is free from vibration, and for this reason the closest attention should be given to all terminal connections on the rear of the board, as it is often exceedingly difficult to find a burned off control wire which follows when the terminal nuts work loose.



CONTROL-CIRCUIT FUSES AT TOP OF CONTROLLER

A very dangerous condition occurs on elevators of the direct-current type, without a governor, when a loose contact is encountered in the shunt-field circuit, which of course causes the motor to "race," due to running on the series winding only. The writer encountered a case of trouble of this nature in an old-type passenger elevator; the poor contact was of a "floating" nature and would cause the car alternately to slow down and speed up. The entire shunt-field circuit was carefully gone over and all connections cleaned and tightened, which removed the trouble. Needless to say, if regular inspections of the equipment had been made, this trouble would not have occurred.

The workmen should be required to turn in a report on each shutdown of equipment under their supervision, giving the nature of the trouble, the cause, the time and by whom reported out of service, time operation was restored and if any work remains to be finished by the succeeding shift. This enables the regular shift troublemen to take up the repair work, in case of unusual breakdowns, where the elevator repairman leaves off, since it eliminates overtime work, which is undesirable and should seldom be necessary in a large organization. A weekly report should be given the head of the department by the regular maintenance man, stating the number of replacements made and the condition of each hoist or elevator.

All storeroom requisitions for material for use on elevators are made out in triplicate; the triplicate copy is filed by the electrical department for the summary of material used per month, which summary is consulted in ordering repair parts for the control and other apparatus used in connection with the elevator equipment. With the use of this method in ordering material, the amount of money invested in repair parts will be kept at a minimum, for reports covering several years show that the only parts necessary to carry in stock are the contactor tips. The magnet coils and other parts usually show signs of deterioration previous to a complete breakdown, so that the material may be ordered and put on the job without being carried in stock. Commutator failures are comparatively rare and usually can be repaired in a short time. When one is worn out, a new one can usually be secured soon enough to prevent trouble.

Exposed control wiring in conduit has given much trouble from insulation breakdowns due to condensation of moisture in the conduit at night. With the large number of wires usually encountered, considerable time is consumed in disconnecting and testing the wires. In a system using a 250-volt grounded return, the control wires would often get excessively hot, in case of a ground on these wires, before the main control fuses would blow. To eliminate this trouble and facilitate testing of the control wires, a board 6 in. wide and 40 in. long was mounted over the regular control board, as shown in the figure. On this board is mounted 21 single fuse blocks for 10-ampere 250-volt capacity fuses. The control wires, which originally fastened to the terminal block along the top of the control board, were moved to the top of the fuse blocks, and a jumper was run from the bottom of the fuse blocks to the corresponding terminal on the board. The individual fuses were rated much lower than the main control fuses and would blow in case of trouble on any of the corresponding wires in the conduit or external apparatus. The wires were tagged at both ends and at all junction boxes, so in cases of trouble it was only necessary to change a wire to a spare or locate the ground in the corresponding limit switch or control box.

To obviate the trouble with condensation in a horizontal conduit run, a lead-covered cable was substituted, which consisted of 22 No. 14 B. & S. copper conductors which were each rubber-covered and the whole covered with a lead sheath. In the cable there is little room for air and consequently grounding from condensed moisture is eliminated. Likewise there is not the danger of tearing the insulation which is encountered in pulling a large number of small wires in conduit around bends. The cable was run about 75 ft. from the control board to the first exposed junction box and during several years use has not caused an interruption to service.

EDITORIALS

Basic Principles Versus Disconnected Facts

SOME men seem able to handle with ease almost any situation that arises, whether or not it is just in line with their ordinary duties. Such are, in the best practical meaning of the phrase, technically trained, no matter where or how they acquired their ability. But it will almost invariably be found that these men are accustomed to dig out the reasons for things and base their action on a knowledge of fundamental principles.

When a man is learning arithmetic, he does not start out to memorize the sums, products, etc., of all possible combinations of figures. Rather he learns the answers for a small group of simple problems (for example, the multiplication table) and then drills himself in the use of these to work out any problem in addition, multiplication, etc., that may arise.

Likewise, in the power plant, the man who fails to recognize that each problem is merely a new combination of the same old fundamental laws, will not find his previous experience of much help. No matter how many years an engineer works, he will always be bumping into something that he never saw before. In the long run it is easier, as well as much more effective, to maintain a workable knowledge of a few fundamental principles than to attempt to keep in mind an immense number of disconnected facts.

If Cold Storage, Why Not Coal Storage?

OVER a half billion cubic feet of storage space is under refrigeration in the United States for the preservation of foodstuffs. And in this space the marketing industries of the country preserve, according to the season of the year, between one and two and one-half billions of pounds of butter, cheese, poultry, meat, apples, etc. It is an enterprise in which large investment has been made in order that a stabilization of an industry otherwise grossly seasonal in nature may be accomplished to the good of the entire community.

In the United States there is used, roughly, half a billion tons of coal a year. Some are sufficiently forehanded to buy this coal more or less regularly throughout the year, or even still more far-sighted and buy at seasons of low demand and place in storage for the seasons of maximum use. There are no statistics available, like those referred to from the Department of Agriculture for cold storage, which can tell the extent of investment or the capacity of coal-storage plants of the country as a whole. However, it is safe to say that the capacity of such plants and the tonnages handled are almost a negligible percentage of the total fuel requirements when contrasted with the percentage of perishable foodstuffs which necessity compels stored under refrigeration.

This is the season of the year at which to talk over and plan out next spring and summer's fuel schedule. If careful consideration is given to the problem during the next three months, it will be possible for coal users to make their contracts under conditions most favorable for the betterment of the entire industrial fuel situation. Whatever effort can be made in that direction will certainly be well worth while.

The Growth of an Idea

IN THIS issue of *Power* there is a short article on the use of the Maxim Silencer in the power plant. The history of this silencer is an interesting example of the way one thing can lead to another.

The completion of the original invention was delayed until the way to keep the gases in and let the bullet out was suggested by close observation of the vortex of a discharging bath. Then the application of silencers to firearms suggested their use on more peaceful apparatus such as the exhausts of internal-combustion engines. Lately, they have found use in all sorts of places where the inlet or discharge of any gas produces objectionable noise.

This is merely one of many instances where the clear observation of some simple natural phenomenon right at hand led to inventions of practical importance. For example, Michael Faraday was "playing with electricity" early in the last century. It is doubtful whether any hard-headed business man of that period would have been willing to admit that it was anything more than play. Even after Faraday discovered, in the year 1830, the principle of electromagnetic induction and built a simple form of electrical generator, the average scientist, and even Faraday himself, had no conception of the remarkable effect that this invention would have on future civilization.

Another familiar example is that of the boy who was tending one of the early steam engines in the days when the valves had to be worked by hand every revolution, there being no valve mechanism. Fortunately for the world, the boy was lazy and looked around for some means of escaping this mechanical tyrant. Being bright as well as lazy, he noted that a certain part of the engine moved back and forth in time with the valves, whereupon he connected the valves by cords to the proper portions of the engine and ran off to play.

Countless other illustrations could be given to show that much of the world's progress is due to the few people who really *see* what is going on all around them and then have the imagination and initiative to apply what is learned.

A Frequent Cause of High Maintenance Costs

PROPER lubrication of a bearing may be defined as supplying the right amount of the proper kind of lubricant to the bearing at all times. With standard types of electric motors equipped with sleeve bearings, it has become almost universal practice except in very small sizes to provide an oil well in each bearing housing from which the lubricant is supplied to the journal by a ring.

This device, although very simple, is one of the most effective means for lubricating bearings of industrial motors. It is probably this fact that has caused many abuses in this important feature of operation, which have resulted in expensive repairs.

With a standard type of motor operating under normal conditions the cost of lubricant should be so small as to be negligible when compared to the total operating costs. Therefore, there is no doubt that the best grade of oil for the purpose should be used. After a proper grade of oil has been secured, it does not cost any more to see to it that the machine is properly lubricated, than it does to do otherwise, and generally the cost of faulty lubrication is so high when compared with the proper method, that the latter fades into insignificance. Pouring oil into motor bearings periodically without ascertaining that other conditions in the bearings are correct has been the cause of high maintenance charge and unsatisfactory motor operation in many plants.

If there is sufficient oil in a bearing and the ring is stuck, it is not more lubricant that is required to prevent the bearing burning out, but a removing of the cause of the ring not running freely. When the return passages to an oil well are stopped up and the oil is leaking out as a result, putting in more lubricant gives only temporary relief to the bearing and adds to the danger of the windings breaking down from becoming oil soaked. It is only a few minutes' work to wash the bearing out and put in clean oil, but if the winding becomes oil-soaked and burns out, a long and expensive job is the result; and unless a spare motor is at hand, it will also cause a number of days' loss in production. Too much lubrication may cause even more expensive repairs than not enough, but the cost of the right amount properly applied is so small that no operator can afford to take a chance with any other condition. Remember that oil attains its highest qualities as a lubricant only when combined with common sense.

Fifty Years of Power Development

IN THE year 1869 a million and a quarter horsepower met the requirements of American manufacturers. In 1919 the figure had increased to over twenty-nine and a half million horsepower. Yet this is but a small part of the story. Back in 1869 folks lighted their homes with oil; the "horseless carriage" was a curiosity; steam railroads were in use, but scarcely comfortable; buildings were no taller than a man could climb conveniently without an elevator; the very life of man everywhere was regulated largely by the limitations of his physical strength. Many things have contributed to the present mechanical age. Yet for an outstanding cause, need we look further than the development of electric power? Certainly, electricity has had the biggest part in the application of mechanical power, not only to many kinds of work formerly done by the strength of man or beast, but also to countless new tasks that our forefathers never dreamed of.

To meet these needs for light and transportation, and for other purposes outside of manufacturing, thousands of steam and hydraulic power plants have been built, which now have a capacity of not far from twenty-five million horsepower Add to this, at a rough guess, about fifty million horsepower for steam railroads, and you have, with the twenty-nine and a half million horsepower used in manufacturing, well over one hundred million horsepower as a measure of the power in use today in this country. And this does not include the great additional power of automobiles, nor of motor boats and ships.

With this as a background one may find increased interest in the statistics just given out by the Government as the result of the 1920 Census of Manufactures. The summarized results of that census, especially those relating to power used, are given on another page. From these figures has been calculated the ratio of horsepower per wage earner for the United States and for each of the separate states. This ratio is significant, and much can be learned from it. It has been found to be 3.25 for the United States and to vary from 1.9 to 12.2 among the different states. This variation is not surprising, in view of the many different kinds of industries to be found throughout the great length and breadth of the country.

In 1869 this ratio was about six-tenths horsepower per wage earner. It grew rapidly greater until the beginning of the Twentieth Century, but since the census of 1904 its increase through each five-year census period has become less and less pronounced. From 1914 to 1919 it gained only 0.05, reaching 3.25. Is this the ultimate figure? Has industry reached so high a state of development that it can never use more than this 3.21 horsepower for each of its workmen?

The figures seem to indicate that such is the case, but nature does not move in smooth curves nor in straight lines, and the work of man, which is, after all, mainly the harnessing and controlling of nature, may well be expected to follow the same whimsical course. Who knows what unsuspected conditions may be discovered, what unknown forces may be utilized, to meet the never-ending requirements of a world that has learned to stop at nothing? How can one know that something will not happen to put a kink in the nice curve that one may draw in a spirit of assured prophecy?

The continued upward trend in the monthly totals of water power and fuel power produced by public-utility plants in the United States is encouraging. If the compiled reports for December show a normal increase above November, as may well be expected, there will be established a record for public-utility power production in the United States. As a matter of fact, the November figures, just reported by the United States Geological Survey, of almost 3,650,000,000 kilowatt-hours are within less than three per cent of the record month. With such consumption of power it seems quite certain that the skeptics who still tell depressing tales as to bad business will soon lose any arguments in support of their wailings.

The fellow who handles an electric circuit without first determining if it is alive or dead, may never know, as is attested by many fatal accidents caused by assuming that a live circuit was dead. It does not take long to make the necessary test to ascertain if the line is alive or to take the proper precaution to provide the necessary protection. Then why take a chance, after which it may be too late to be cautious?

Organized engineers have been largely responsible for getting the House to pass the Patent Office relief bill, and in Philadelphia they are actively working for the Sesqui-Centennial Exhibition. The engineers are getting into their stride.

PRACTICAL IDEAS from PRACTICAL MEN

Give Publicity to Useful Kinks

There is an opportunity for chief engineers of power plants to help themselves and their fellow engineers by writing up for publication special devices or improvements they have worked out in the course of the day's work. It is rare indeed to find anyone who does his full duty in this respect, one of the chief reasons being that the engineer considers the device he has worked out to save labor, reduce maintenance or improve efficiency is not of such moment as to warrant publication. With few exceptions this opinion is erroneous. There is such a variety in plants and in the attainments of engineers in general that the majority of these items would prove generally useful.

As a typical instance the writer would refer to a device used by J. V. Rahilly, chief engineer of the Peoria plant of the Illinois Traction System. He had been troubled, as hundreds of other engineers have been, with the corrosion of coal spouts. Having replaced metal spouts until he became tired of it, he installed wooden spouts, using 10-in. standard wood water pipe. Some of these spouts have been in over three years with no replacements and no indication of the need of early renewals.

A. C. Cramer, chief engineer of the Muncie plant of the Indiana General Service Co., had a similar trouble with coal spreaders at the end of his coal spouts. These were costly to construct on account of being of a difficult shape to build, so he worked out a wooden construction which has solved his problem in a very satisfactory manner.

Lindsey Hurst, chief engineer of the Belknapp Hardware Co., Louisville, Ky., had trouble, as hundreds of other engineers, have had, with his stokers creeping away from the furnace front, allowing air to enter between the stoker front and the arch. Most engineers plaster this space with asbestos, but Mr. Hurst thought of a better plan. He connected the stoker side frames to the furnace front on each side by means of light turnbuckles and tie rods, thereby holding the stoker rigidly against the furnace front. The stokers are of the chain-grate type, and when it is necessary to withdraw them from the furnaces, it is easy to slack off on the turnbuckles, disconnect them and withdraw the stokers. The turnbuckles serve an additional advantage when the stoker is pushed back into the furnace, in that they can be connected to the side frames and the stoker pulled up the last inch or two tightly against the furnace front on either side.

These are good practical ideas, valuable to engineers in other plants. Credit is due engineers who develop ideas of this kind, and greater credit to those who share them with other engineers. T. A. MARSH.

East Chicago, Ind.

Tube Losses in Water-Tube Boilers

When a plant becomes affected with chronic tube failures—that is, not the destructive rupture kind, but the small bag and leak type that the operator of water-tube boilers knows so well—the first thing that is looked for is the amount of scale the tubes contain. As a general thing one is surprised by the small amount of scale present, yet tube after tube will show up with small bags and leaks. I have seen plants suffering to the extent of fifty tubes a month out of a total of fifteen boilers.

After considerable investigation as to the kind, etc., of feed water used, it was found that the trouble was due, not necessarily to a large amount of incrusting solids in the water, but to a change in the general characteristics of the same. For instance, in one case, an intermittent water-softening plant was used, some additional capacity was installed, the newly installed settling tank being 10 per cent larger than the original three tanks, each of which held enough water during the off-peak periods to run about seven hours.

The operator, through ignorance or carelessness, used the same amount of lime and soda ash in all four tanks. The change in the water resulted in the loosening of a very light scale in the tubes. The result was that it piled upon itself to the thickness of several layers. This accumulation took place in the lower rows over the fire, or between the front wall and bridge wall, resulting in the bagged tubes. After the variation in the quality of feed water was stopped, the two lower rows of tubes were brushed free of the loose scale, which ended the trouble.

It seems that a change in the water will at times result in the loosening of large amounts of scale of negligible thickness, which has a tendency to accumulate over the fire. I have seen the same results where a central station furnished a small amount of steam heat without a return of the condensate. Everything moved along nicely during the heating season, but after

it was over and a lesser percentage of makeup water was used, there began an epidemic of lower-row tube failures. Investigation showed the accumulation of several layers of this scale as aforementioned. The two lower rows of boilers were brushed, and the trouble was stopped.

So, if operators suffering from tube failures of the kind mentioned will work day and night and brush the lower rows of all boilers, the trouble will cease in a short time. Of course such cleaning should be only added to the thorough brushing or turbining of the entire boiler, the frequency of which is determined by local conditions. JOHN F. HURST.

Louisville, Ky.

What the Indicator Disclosed

A certain four-valve engine was equipped with gridiron steam valves and Corliss-type exhaust valves. The dashpots were badly worn, and it was almost impossible to get sufficient cushion to keep them from pounding. The steam-valve stem was so worn in the stuffing box *A*, Fig. 1, that on starting the valve would stick open for a few strokes. When the engine got up to speed it gave no trouble.

The engine was carrying a good load when stopped at noon, and on starting again the usual trouble with the worn valve rod sticking in the stuffing box was

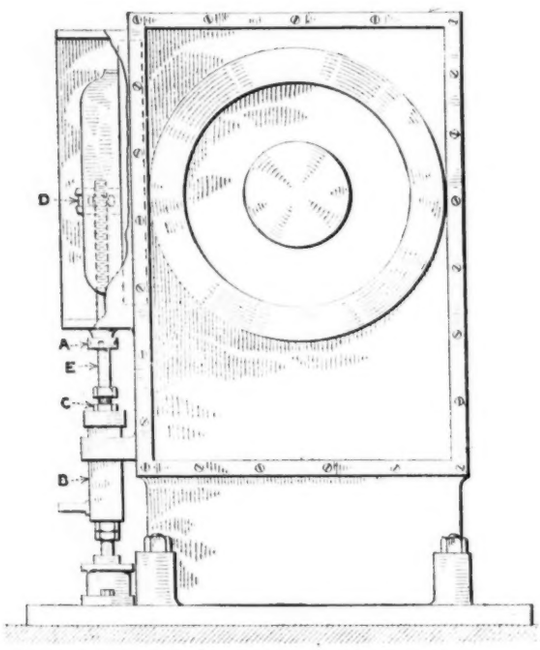


FIG. 1. SHOWING DESIGN OF STEAM-VALVE GEAR

experienced. At about 1:40 p.m. the engine developed peculiar jars and unsteady motion; the load varied and was heavy. An examination showed that the dashpot on the head-end steam valve closed only part of the time, although it tripped, and loosening the stuffing box and removing the cushion plug from the dashpot did not remove the trouble.

An indicator was attached and the diagram Fig. 2 was taken. On some four-valve engines this diagram would indicate that the eccentric rod or the hook rod was too long, but how could such a thing happen while running? The trammel points showed that the rods had not moved from their original setting and the locknuts were tight. If the eccentric had slipped, the steam admission would show late on both ends of the diagram. With an engine having but one eccentric, all events would be late.

About this time it was discovered that the valve stem was jumping out of the crosshead cup about $\frac{1}{8}$ in. It was held in the cup by locknuts *C* screwing against the

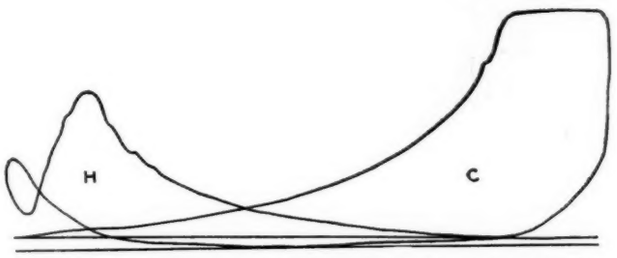


FIG. 2. DIAGRAM BEFORE CHANGES WERE MADE

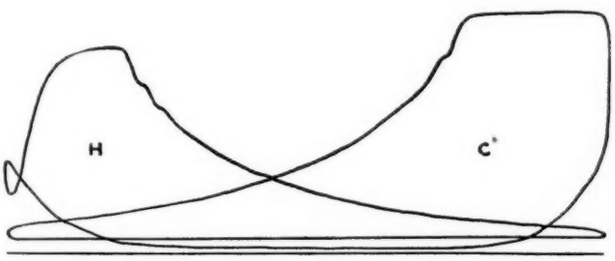


FIG. 3. AFTER MAKING THE FIRST ADJUSTMENT

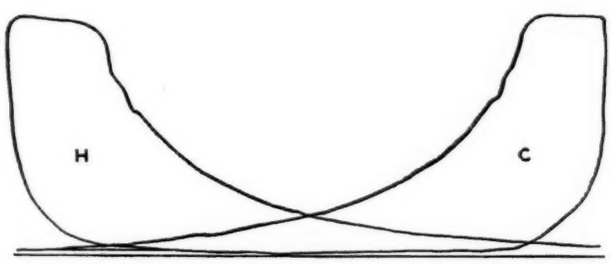


FIG. 4. AFTER ADJUSTING THE VALVE END TWO AND THREE-QUARTER TURNS

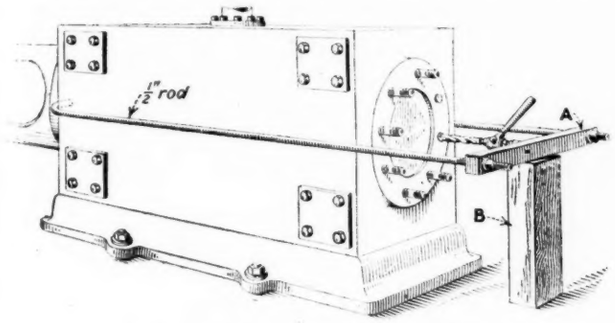
guide *B*. The cause of the late admission on the head end of the diagram was thus made clear. The valve stem had been turning around as the valve closed and had screwed the threaded end so far into the nut *D* in the steam chest that the valve had too much lap and could not open to full port, hence the late admission and low steam line.

The locknuts *C* were loosened again, and while an assistant held the latch from hooking on, an 8-in. Stilson wrench was put on the valve stem at *E* and the stem screwed out of the valve nut in the steam chest a three-quarter turn. The diagram shown in Fig. 3 was the result, which was an improvement. While the change was being made, the latch was allowed to hook on and open the valve every third revolution. The adjusting operation was continued to two and three-quarter turns of the valve spindle, which raised the gridiron valve and reduced the excess lap of the valve, and a third diagram, Fig. 4, was taken and no further change was made. The dashpot closed sharply thereafter, and the engine ran without its peculiar jar and unsteady motion. R. A. CULTRA.

Cambridge, Mass.

Method of Removing Broken Stud Bolts

In one instance two stud bolts on an engine were accidentally broken off flush with the cylinder while the cylinder head was removed. It was necessary to get the engine in service at once, and the problem was



RIG FOR DRILLING BROKEN STUD BOLTS

to remove the two broken bolts with the least loss of time. The only tool available was a hand ratchet drill.

The cylinder was 12 x 36 in. and the plan adopted was as follows: A 2-in. square iron rod *A*, long enough to reach across the end of the cylinder was obtained from a local blacksmith shop and a hole was drilled in each end for a ½-in. rod which was threaded at one end and bent at a right angle at the other end.

When the rig was put in place, the square cross-piece was held at the proper height by a 4 x 4-in. stick *B*. With the ratchet and drill in place the nuts on the rods were tightened and the studs were soon drilled out to shells. Then by driving a square hardened drift pin into the hollow stud, it was easily turned out.

Birmingham, Ala. C. A. ATKINS.

"Could Not Put It Over on This Fireman"

I was watching a fireman cleaning fires at a large upright boiler recently and was amused to observe that after the fire was thoroughly cleaned, he carefully placed an ordinary brick halfway in on the grate and then pulled his fires over the clean grate and partly covered the brick. He then shoveled f esh coal on the whole, covering the brick. I learned that he did the same thing at each of the six charging doors of the circular furnace.

I had never seen that done before, and so, after he had finished, I asked him why he placed bricks so carefully in the fires. His answer was that if he put iron on the grates it would melt, but that the brick would remain there if the night man failed to clean the fires. He further stated that the night man was becoming lazy and was not cleaning the fires, which made the work so much harder for him. If the night man cleaned the fires, the bricks would, of course, disappear.

The hardest part of the fireman's job is cleaning fires, and, therefore, when extra work was put on this fireman, he resented it and used his head and set his brick trap; and it proved his contention on two occasions, after which the night man was informed to his surprise. After that the fires were cleaned every night.

New Haven, Conn. WALTER J. BITTERLICK.

Equalizer Caused Short-Circuit on Armature

On multipolar, multiple-connected armatures trouble may be experienced, due to unequal distribution of the current through the several armature paths. This will underload some brushes and overload others, and if the current inequalities are too great, the overloaded brushes will spark. The unequalized conditions are minimized as far as possible by cross-connecting some of the commutator bars which are at the same potential when the armature is in operation. In the diagram one equalizer is shown in dotted lines to connect three equipotential bars, another equalizer would connect three more and so on until the desired number are connected.

In a certain instance a 6-pole armature came into the shop for repairs. Apparently, the trouble was a burnout among several leads where they were connected to the commutator. The leads were spliced, reinsulated and reconnected to the commutator. It was necessary to send the armature out without any conclusive test, because the motor frame was not available, and when subjected to a bar-to-bar test, an equalized armature will give indications similar to those obtained from an armature having short-circuited coils. The armature was returned very soon with the complaint that it would "turn a little and then stop."

In the diagram the length of the equalizer is shown to connect bars located at points twice the distance between brushes. In this particular machine six sets of

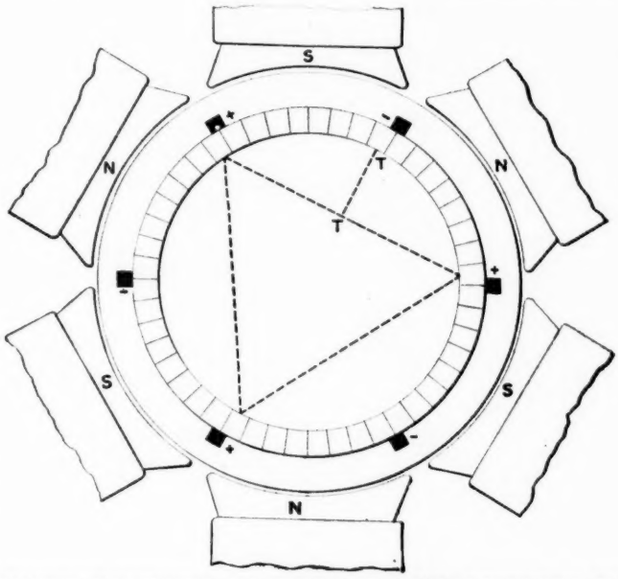


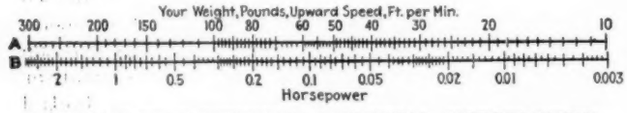
DIAGRAM SHOWING HOW SHORT-CIRCUIT OCCURRED ON EQUALIZER

bars were equalized and the equalizing conductors were made up into a wreath and installed behind the commutator under the regular leads. As their overlying insulation had appeared to be good, the repairman had not disturbed it. Investigation disclosed that under the insulation two equalizer conductors had become short-circuited to each other in a manner such as to produce the condition indicated by dotted line *TT* in the diagram. Here it will be noted that the equalizer short-circuits the brushes. On removing the short-circuit, operation became normal and no further complaint was made.

Brooklyn, N. Y. E. C. PARHAM.

What Is Your Horsepower?

By means of the figures on the accompanying scale one can easily and quickly determine personal horsepower exerted in climbing stairs. For example, if your weight is 150 lb. and if you can climb stairs at the rate of 60 vertical feet a minute, find the 150 in line *A* and the 60 in the same line. Then find the point halfway



SCALE FOR COMPUTING PERSONAL HORSEPOWER

between these two points. Directly below this mid-point in line *B* is the answer—very close to 0.273 hp.

If you weigh 100 lb. and if you can race up the stairs at the rate of 100 ft. a minute, your horsepower would be a trifle over three-tenths of one horsepower. If you weigh 300 lb. and can't go any faster than 10 vertical feet a minute, you are doing less than one-tenth of one horsepower. The figure below the mid-point is the answer, always.

The chart may prove of interest for estimating your probable horsepower if you care to exert yourself to your limit.

W. Y. SCHAPHORST.

Newark, N. J.

One Way to Remove a Tight Key

The key of a pinion that had resisted all efforts was easily removed as follows:

The worn-out pinion was of soft steel, milled and cut very close for silent-chain operation. I intended to saw through to the key way, but to my surprise, after I had taken a $\frac{3}{16}$-in. cut across the face of the pinion, I pulled the key out with my fingers.

Dixmont, Pa. C. W. PATTERSON.

Does a Condenser Decrease the Load on an Engine?

The work an engine is doing in driving the machinery in a mill or factory and in overcoming its own friction, is the indicated horsepower of the engine and is proportional to the area of the diagram taken from it; and while any change in the machinery will manifest itself in a corresponding variation of that area, it is not affected by changes in the back pressure. It is evident that, with the same initial pressure and speed, the mean effective pressure necessary to do this work is the same whether the engine is running condensing or non-condensing.

Since the removal of the back pressure shortens the cutoff with the same initial pressure, load must be taken from the engine in some way, or the point of cutoff would not have changed. That is what has happened, and the load removed is represented by the power required to force the spent steam out into the atmosphere.

There is no power in a vacuum. All the power comes from the pressure of the steam in the cylinder. All the condenser does is to remove the back pressure; in other words, it makes available for useful work the power conferred upon the atmosphere by virtue of a vacuum. An equivalent of this amount of power is used in the non-condensing engine, in overcoming the atmospheric pressure, at the expense of the coal pile, but it does not show on the indicator diagram.

The condenser adds nothing to the power of the engine; it will work to the same limit, condensing or non-condensing, the only difference being that it will do more useful work in one case than the other.

Some twenty-odd years ago someone asked this question of the *American Machinist*: "If in the cylinder of a non-condensing engine the pressure is 50 lb. per sq.in., what will it be with a condenser, and why?" And he got this answer: "It will be 50 lb. as before. The condenser does not add anything to the pressure; it simply removes more or less perfectly the pressure of the atmosphere."

F. B. MALLET.

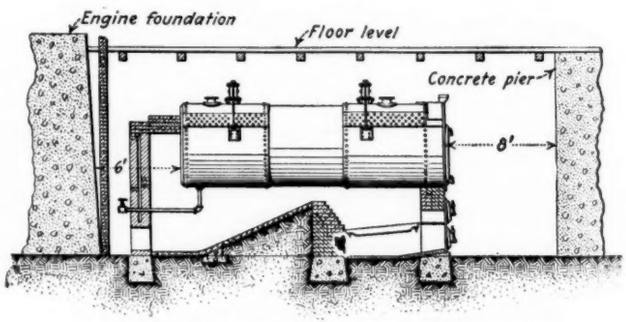
Minneapolis, Minn.

Removing Boiler Tube Simple After Knowing How

An incident that occurred several years ago was recently called to my attention. It became necessary to remove a tube in the third row of a return-tubular boiler. Directly in front of the tube and about eight feet from the boiler front was a thick concrete pier. It was impossible, of course, to pull the tube out sufficiently to clear the other end in the front tube sheet, and the engineer started to drill a hole in the pier through which to pass the boiler tube.

After working diligently for a while, realizing that he had tackled a real job, he decided to abandon the plan and remove the tube through the rear tube sheet and boiler setting. Accordingly, a hole was made in the rear end of the boiler setting, and in the wall that divided the boiler room from the engine room. When the latter hole was made, the engineer discovered that he had run up against the engine foundation, which came close to the partition wall, and further progress was barred in that direction, the engine foundation being about six feet from the rear tube sheet.

These obstructions made the engineer rather dizzy until someone suggested that the two tubes directly

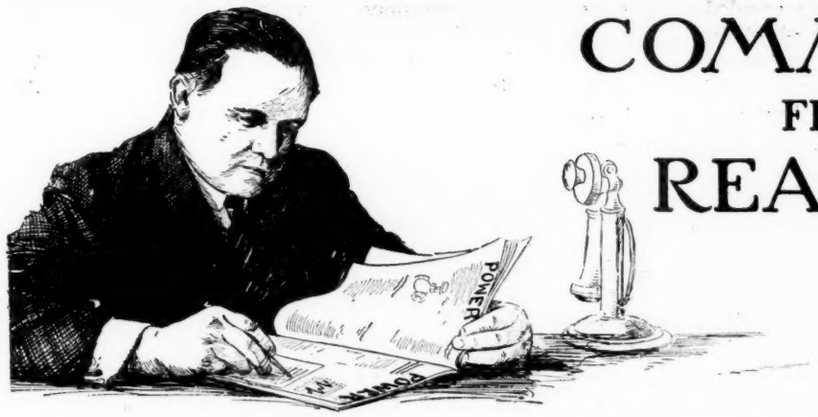


BOILER SET BETWEEN CONCRETE PIERS

below the one to be removed be taken out, even if it did mean their ruin, and then the third tube dropped and removed, together with the other two through the manhole. This could be done, as the manhole opening would permit swinging the tube sufficiently to clear the concrete pier in front of the boiler. This method was eventually used, and three new tubes were put in.

In many boiler rooms there is not sufficient room in front of the boilers to permit of tube replacement without unnecessary loss of time and needless expense.

Buffalo, N. Y. J. A. OSGOOD.



COMMENTS FROM READERS

It Costs Too Much

Poet Laureate R. T. Strohm has discovered another horrible example, and although the example described by his poem on page 887 of the Nov. 22 issue of *Power* is serious enough, I think I know of one that is worse, and the pity of it is, it's true.

A high-grade CO_2 recorder was bought by the owners of a plant and has been standing on the engine-room floor for over eighteen months, but not installed. A back-pressure valve was bought and has been lying on the floor for over six months, and the only reason discoverable for not installing them is the expense.

In a moment of weakness the owners of the plant adopted their engineer's recommendation and improved the boiler plant and the heating system with the result that last year the savings amounted to, as I happen to know, about $30,000. The back-pressure valve would save its cost in two seasons, as there is always an insufficiency of exhaust steam for heating purposes. It is pretty well known that proper control of the furnace will effect a saving of 20 to 25 per cent in the average plant. It cannot do that in the plant in question, but 10 per cent might be possible and 7 per cent would amount to about $3,000 per year. However, they recovered from their weakness in time to realize that the installation of these two items would "cost too much."

R. McLAREN.

Toronto, Ont., Canada.

The Origin of "Engineer"

The dispute as to whether the word "engineer" or "engineman" should be used is due to a misinterpretation of the meaning of the word engineer.

The dictionaries of the English language ascribe the orgin of this word to the latin word "genius," and the French language uses the word "genie" for engineering and the word "ingenieur" for engineer. I have come, however, to a different conclusion since some German student of the oldest dictionaries has discovered the origin of the word "engineer" in the old latin word "incingator," which indicated the artisan who erected the moats or wall girdles around the cities of medieval times. The present Italian language pronounces this word with the sound of "chi" in the second syllable.

It is very likely that the engine of the incingator, the gin pole, was called "macchina del incingatore," and came into the English language with a shortened and mutilated form, becoming the mother of the word "gin," operated today by the hoisting engineer.

Upon this basis one would be willing to admit that the name "engineer" is rather more justifiably used by the gin pole operator, or anyone who runs an engine, than by the technical man.

"Engineman," instead of "engineer," would fit as badly to the engine operator as "gunman" to the gunner, the operator of the guns of the Army and Navy.

For professional engineers the following might be adopted: Electrologist or electrolog or electrotect for electrical engineer; mechanologist or mechanolog or mechanitect for mechanical engineer; vialogist or vialog or viatect for roadbuilder; pyrologist or pyrolog or pyrotect for combustion engineer, etc.

New York City. PAUL FRANCSEKD.

[The foregoing is published as being of interest because of the writer's study of the derivation of the word "engineer." The dispute no longer exists, except in an academic way, because the word "engineman" was taken out of the reclassification bill and replaced by "steam engineer."—EDITOR.]

Wrecking Compound Engines

W. H. Wakeman, on page 842 of the issue of Nov. 29 in an article entitled "Wrecking Compound Engines," makes an assertion that is not borne out in practice. He states that with five pounds absolute pressure in the condenser and four pounds absolute pressure in the low-pressure cylinder, when the piston starts on the return stroke water will be forced from the condenser to the low-pressure cylinder.

This would doubtless take place if the exhaust inlet to the condenser was submerged in water, but all operating engineers know that in practice the air pump of a jet condensing outfit should have a slight kick at each end of the stroke, which is a guarantee that the pump is handling the condensing water faster than it is being furnished, thereby rendering the submerging of the condenser impossible.

It may be claimed by some that the water from the cooling spray might be forced backward through the exhaust pipe into the low-pressure cylinder, but if we consider the slight inducement to this by reason of a differential of only one pound, its impossibility will be apparent. I have seen several engines wrecked by water from the condenser, but it was always from carelessness in stopping the air pump with the injection water on or from the fact that a suction and a discharge valve were out of position or in bad condition.

Mr. Wakeman also refers to rocking the wristplate in warming up. This is not necessary with a Corliss engine, as the small amount of water condensed in the cylinder at the start is taken care of by the best cylinder drain possible—the exhaust valves.

I have in mind an installation of five cross-compound

engines where the wristplates were coupled solidly by a stub-end brass. This has been in effect for ten years, and the presence of water at starting has never been in evidence. If judgment in rocking a wristplate with steamed turned on is not used, the short repeated blows on the crankpin are harmful. JOHN F. HURST.

Louisville, Ky.

Mechanicsville Boiler Explosion

It appears from the account of the Mechanicsville boiler explosion, published in the Nov. 29, 1921, issue of *Power*, that boilers having butt longitudinal joints sometimes explode, but it is gratifying that in this case there was no rupture of those joints.

A manhole or a dome in or on the shell of a boiler is undoubtedly a source of weakness, and for many years I designed manholes with cast "frames" or nozzles because I always felt that danger exists at this point. Even when nozzles are used, they should be enormously heavy, and the covers made dome shape. In consequence of the trouble of making the joint between the nozzle and cover, and the general dislike of this construction, I changed to the general practice of reinforcing the manhole with the well-known flanged ring riveted to the inside of the shell.

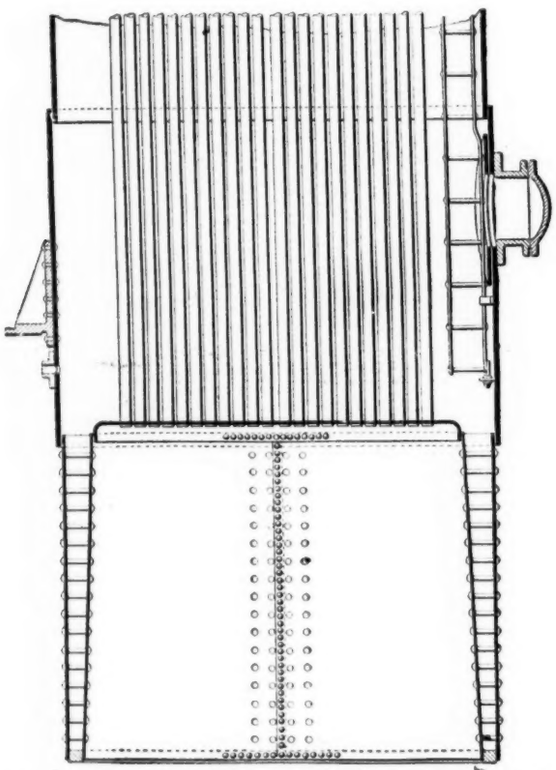


FIG. 1. CIRCULAR MANHOLE, WITH CAST-STEEL FRAME

When an opening is made in a boiler shell and it is reinforced in some manner, the stress in the shell is transferred to the reinforcement by means of the rivets. The rivets are overhung pins and are capable of bending. If they do not fit the shell and reinforcement, they do no good until the boiler plate stretches somewhat and possibly beyond the elastic limit. Here, then, is a part of the boiler that requires the utmost thoroughness of workmanship. Even, however, if the workmanship is of the best, the overhung features of the rivets, which is unavoidable, may cause yielding and the shell plate may be overstrained.

Still further, if the workmanship is correct and the reinforcing ring is solidly joined to the shell, it will

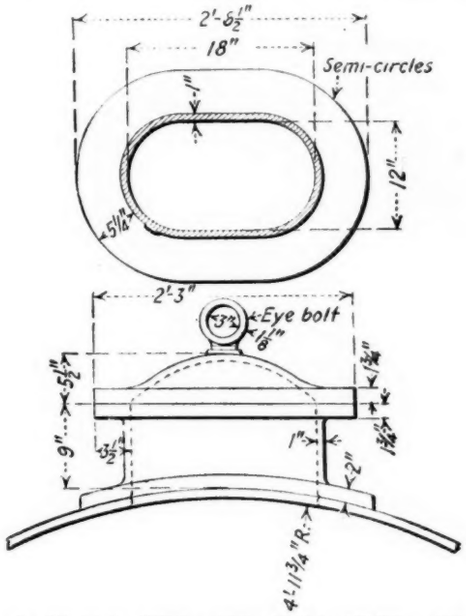


FIG. 2. MANHOLE WITH STRAIGHT SIDES AND SEMI-CIRCULAR ENDS

yield because it is curved in two directions and does no good until it is slightly bent by the stress. The ring is a bent tie trying to make up for the weakness of the shell. It cannot, therefore, be free from being a source of danger. Anything that bends back and forth is in danger of breaking in time.

What can be done to prevent this danger? It is important to make the manhole reinforcement superlatively strong and rigid. When the flanged steel is used and riveted, as it is, to the inside of the shell, there should be an outside ring riveted to the outside of the shell of larger diameter than the inside ring and having one or two rows of rivets outside of those which pass through it and the inside ring, the pitches of these rivets being greater than those through the inside ring. It would be best to have the outside ring flanged outward also, and this would incidentally be convenient in limiting the nonconducting covering.

Still further, the shape of the manhole and reinforcement should not be elliptical, as they are commonly made, but should be oval with straight sides and semi-circular ends. This would put some of the reinforcing metal in straight lines and avoid part of the dangerous elasticity.

On the whole I think it would be best to avoid manholes in the shells of boilers and place them on the heads where possible. This is occasionally done. I should also recommend that domes never be used on stationary boilers.

Finally I am of the opinion that the boiler explosion in question originated at the manhole.

The accompanying illustration Fig. 1 is of a circular manhole with cast-steel frame or nozzle and having a wide circular reinforcing plate riveted to the inside of the shell. Fig. 2 shows a cast-steel frame having straight sides and semi-circular ends. These were both designed over twenty years ago. F. W. DEAN.

Boston, Mass.

Valves in Water-Column Connections

Discussion relative to the installation of valves in water-column connections have appeared in several recent issues of *Power*, and while a considerable difference of opinion is expressed by contributors, there still is something more in the way of constructive discussion to be advanced, and it is my purpose to suggest some considerations which, so far, have not been especially emphasized.

In the early nineties occurred my first experience with water columns fitted with valves in the connecting pipes and also with high- and low-water alarms. One Monday morning about half an hour before the regular starting time, and while the crew were getting ready for the day (in this plant the fires were all allowed to go out Saturday night except in the coldest weather), one of the whistles was heard to blow and shortly the fireman was heard blowing down the boiler. This did not stop the blowing of the whistle, and after it seemed that an excessive amount of water was being blown out, I started to investigate. No. 9 boiler showed full to the top of the glass, but on opening the water-column blowdown valve the water in the glass fell and the whistle stopped for a moment and then blew for low water. Fortunately, the fire was dull, in fact almost black, and no damage to the boiler resulted, as the fire was hastily covered with green coal. When the boiler seemed to be in suitable condition, the feed valve was opened and the water level raised to normal, and from the time required to do this it was believed that the boiler had been almost empty.

Investigation showed that a steamfitter had been repairing the float in the water column on the preceding day and that although he had opened the upper valve while up on the stepladder, he forgot all about the lower one, with the result that when steam was raised, condensation soon filled the column until the whistle blew. Some one is heard to say that such a thing was inexcusably careless of the man doing the work; but we used to find them like that, and sometimes I am inconsiderate enough to wonder if the number has lessened during the years that have gone by.

Another unpleasant incident due to the presence of a valve in the water-column pipe occurred when a repairman in a power house had occasion to replace a broken whistle base on an alarm column. The boiler was banked as it was the off-peak period, and as the leakage of the whistle valve bothered him, he closed both valves on the connecting pipes, did the job and left, forgetting to open the valves again. These boilers were all fitted with automatic feed-water controllers, and evidently no one watched the water level very closely for the boiler ran through the remainder of that watch and well into the next when the fireman noticed that the water level was unusually steady for peak-load conditions, as there was ordinarily considerable movement. He investigated and found the valves closed and later that the boiler had run for several hours at a good rating in that condition and was saved from injury only by the faithful action of the feed-water controller.

More carelessness, but it happened, and unfortunately, in some similar manner it will happen again, for the careless, the indifferent and the forgetful find their way into the power plant now even as they did in the past.

When the size of the unit is small, as in the case of the return-tubular boiler, the expense of dropping the pressure in order to make minor repairs is not of sufficient amount to warrant serious consideration and in such the omission of these valves may well be in order, but when the unit is of 10,000 sq.ft. or more it is a different sort of thing, for it may cost $50 in fuel alone to do this, to say nothing of the loss of use, possibly at a time when it is needed badly.

I have had the responsibility of chaperoning the installation of several plants during the last few years in which the boilers used were designed for 250 lb. steam pressure and a considerable number of which are of 10,000 sq.ft. or more, and have, on the larger units regularly installed valves in the water-column connections, and believe this to be the proper thing to do for this class of work.

These installations are, in general, made in the following manner: Each of these larger boilers is equipped with two water-columns of the high- and low-water alarm type, one on each side of the boiler. Each column is piped to the boiler with extra heavy iron pipe-size brass pipe and extra-heavy cast-iron pattern, brass screw fittings. The valves used are extra-heavy bronze gate valves with outside screw yoke and are intended to be located in as conspicuous positions as possible. The valves are either sealed or locked in an open position, and it is expected that the engineer in charge is alone responsible for any manipulation of them. It is found that the second water-column is of decided advantage on these boilers and I am giving serious consideration to specifying them on all boilers for 200 lb. steam pressure or more.

The use of various automatic devices in a power plant is becoming more and more general and in spite of all arguments that they tend to make the operating force careless by reason of placing too much confidence in them, and giving them too little care and attenion, this tendency is bound to increase and the operating force, no longer necessarily selected because of their brawn, must train themselves to the keen, alert attentiveness that characterizes the successful professional man in other lines.

CHARLES L. WARE.

Lawrence, Mass.

Should Oil Country Boilers Be Exempt?

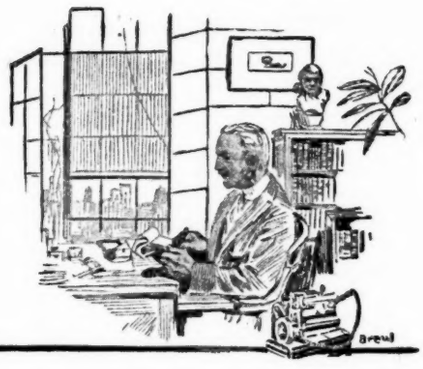
I would like to comment on the article published on page 882 of the Dec. 6, 1921, issue of *Power*, "Should Oil Country Boilers Be Exempt?" In my opinion there is doubt that the rules of the California Industrial Accident Commission were actually lived up to when the inspection was made on May 31, 1921, by the insurance inspector. Is there anything to show that he had inspected so great an item of safety on the boiler as the safety valve to see where it was stuck or whether it acted freely?

The fact that the safety valve was equipped for a lifting device, and again, the fact that it did not have one, presents an interesting proposition. I think that the chief boiler inspector of California should have censured not only the fireman, but also the inspector, for he states that the safety valve had not blown off for many weeks, and only a period of less than two months had passed since the inspection. It is possible, therefore, that the inspector did not go over the safety valve himself.

Not only should the states pass laws requiring persons operating boilers to pass certain tests and examinations, but they should require every inspector to take an oath on every certificate that he has inspected each and every part of the boiler to the best of his ability.

Olean, N. Y. C. W. CARTER, JR.

QUESTIONS AND ANSWERS



Equalizing Cutoffs of Single-Valve Engine

How are the cutoffs equalized in a single-valve automatic engine? E. C.

If the cutoff of one end of the cylinder is later than that of the other, lengthen or shorten the valve rod to obtain the desired equality. If this adjustment gives undesirable inequality of the leads for the average load, then adjustment of the rod length must be such as to obtain an acceptable compromise of leads and cutoffs.

Heating Surface of Iron Pipe

What amount of heating surface should be allowed per running foot of iron pipe of sizes generally used for steam-heating coils? C. B. F.

Coils for steam heating usually are made from pipe having nominal diameters of $\frac{3}{4}$ in. to 2 in. The heating surface of these sizes is as follows:

1	lin. ft. of	$\frac{3}{4}$-in.	pipe has	0.2748	sq. ft.	heating	surface
1	" " "	1 -in.	" "	0.3442	" "	"	"
1	" " "	$1\frac{1}{4}$-in.	" "	0.4345	" "	"	"
1	" " "	$1\frac{1}{2}$-in.	" "	0.4975	" "	"	"
1	" " "	2 -in.	" "	0.6218	" "	"	"

Revolution of Duplex Pump

What is meant by the number of revolutions of a duplex pump? A. R. D.

The term revolution as applied to a duplex pump signifies one complete cycle of the reciprocating parts. The term is frequently used to remove ambiguity in designation of the number of strokes. The number of revolutions per minute is obtained by counting the number of reciprocations made per minute by any moving part, such as a rocker arm or a crosshead. The ordinary duplex pump has two water cylinders each provided with a double-acting piston and therefore a revolution embraces four single strokes.

Cause of Field Coil Burning Out on Motor

On one of our 3.5-hp. direct-current motors a field coil has burned out twice without any apparent cause. The motor has two poles and operates on 220 volts. I would like to know the cause of the repeated failure. C. A. A.

The only reason for this coil burning out is that the apparently unoffending coil is short-circuited and is the real cause of the trouble. This coil being short-circuited, probably nearly full voltage is applied to the coil that has failed. This would cause the current to be approximately doubled, and the heating in this coil would then be increased four times, since the heating effect increases as the square of the current. This increase in heating should soon burn the coil out. By feeling the field coils with the hand when the machine is in operation, it will be found that one is much hotter than the other. The coolest coil is the defective one. On the other hand, if a voltmeter is connected first to the terminals of one coil and then to the other, it will probably be found to read nearly full line volts across the terminals of the coil that has been giving the trouble and nearly zero across the terminals of the other coil. A lamp may be used for this purpose, and when connected to the defective coil it will burn dimly; when connected to the good coil, it will light up brightly.

Measurement of Tube-Heating Surface

A pamphlet intended to illustrate the method of computing heating surface of a fire-tube boiler states that a fire tube 3 in. in diameter and 12 ft. long affords 8.74 sq.ft. of heating surface. My computation is $3 \times 3.1416 \div 12 \times 12$, or 9.4248 sq.ft. What causes the discrepancy? W. P. P.

In computing the extent of heating surface of tubes, the side of the material which comes next to the heated gases is to be used and the measuremnts are to be taken of the inside area of fire tubes and the outside of area of water tubes. The figure 8.74 sq.ft. of heating surface for a 3-in. fire tube, 12 ft. long, results from taking the internal surface of the tube, which is the correct method. The thickness of a standard 3-in. boiler tube is 0.109, making the internal diameter $3 - 2\ (0.109) = 2.782$ in. and the internal circumference is $2.782 \times 3.1416 = 8.74$ in. Hence the true heating surface of a 3-in. tube 12 ft. long becomes $8.74 \div 12 \times 12$, or 8.74 sq.ft.

Distinguishing Iron from Steel Pipe

What simple tests can be employed to distinguish iron pipe from steel pipe? B. H. C.

Several different methods may be employed. One way is to test by crushing the material. For this test cut off an inch of two of the pipe and hammer the ring flat on an anvil. Iron will show a fibrous structure that is easily fractured, showing a dull-gray color. Steel is difficult to fracture, and the fracture will be of bright crystalline appearance. Another test is by rough etching. Dip one end of a test piece in a solution of equal parts of sulphuric acid and water. In about ten minutes the end of an iron pipe will show concentric rings from the acid eating away the iron faster than the cinder layers, while the end of a steel pipe will present a smooth surface, as there will be no layers of slag present. Microscopic examination of the surface of the metal when highly polished usually will reveal the crystalline structure of steel, and in wrought iron will show the inclusion of slag in the form of extremely fine fibers separating the grains of iron.

An Oil-Engine Compressor Valve Sticks

We find that the valves of the compressor on our Diesel engine cake with carbon when the engine runs on low loads for any length of time. What is the cause? P. J. K.

Since this does not occur on full loads, it is evidently due to high-temperature conditions on low loads. The reason the temperature of the discharge is high on low loads is due to throttling the suction air. This lowers the suction pressure and increases the ratio of discharge to suction pressure. The temperatures vary with the pressure ratio, and on low loads it is possible for the temperature of the last stage to be above the vaporizing point of the lubricating oil. As a result the light portions of the oil are vaporized, leaving a gummy residue which settles on the valves. To remedy this, try a high-test oil or run with the suction line open and let the excess air escape through a relief valve.

Why Lowering Boiler Pressure Reduces Engine Speed

Without any change of load or alteration of the governor adjustments, why does lowering of boiler pressure result in reduction of speed of an engine? W. R. S.

Overcoming the same resistance requires the same m.e.p. to act on the piston. In an engine regulated by a throttling governor and fixed cutoff, the same m.e.p. would require the same average steam-chest pressure, which for lower boiler pressure would not be satisfied except for the larger opening of the governor throttle valve that would be obtained for a slower speed of the governor. In the same manner, lower initial pressure of steam supplied to a cutoff engine would require a later point of cutoff for development of the same m.e.p. which would be satisfied by a governor position corresponding to a slower speed than the shorter cutoff corresponding with higher speed required for higher initial pressure. On the other hand, with the same load, increasing the boiler pressure results in an increase of speed, for in the case of a throttling governor the engine speeds up until the governor's throttle opening is no more than necessary to obtain the former steam-chest pressure; and in the case of an automatic cutoff governor the engine speeds up until the cutoff becomes short enough to result in the required m.e.p.

Fair Trial of a New Cylinder Oil

How should a fair trial be made of the suitability of a new cylinder oil? G. D. N.

The first few days' trial of the oil will demonstrate whether it is worthy of a thorough test. Such a test should extend over a period of at least three months, as it takes considerable time for a good cylinder oil to produce a good working skin on the wearing surfaces of the engine and a much longer time than for an unsuitable oil to destroy the good surface produced by a suitable oil. After a few days' trial of an oil under test, the amount used should be gradually decreased to determine the least quantity that will produce smooth and satisfactory running of the engine. At the end of three months' working on the reduced feed the cylinder walls should present a rather dull appearance, coated with a film of oil. When a change of cylinder oil is made, some irregularities may be experienced during the earlier period of test, due to the new oil altering the wearing surfaces. The previous use of unsuitable oils may have caused deposits behind the piston rings and in the stuffing-box gland, and subsequent use of a good grade of oil will clean the surfaces. Hence, the new oil should not be blamed for dirt thus carried out on the piston rod.

Thumping of Engine

We have recently installed a 16 x 20-in. center-crank engine to drive a ventilating fan. All efforts to locate the cause of a thump in the engine have failed. Convinced that the trouble is not in the crosshead, shaft bearing or crankpin, where should we look further for the trouble? A. B. F.

The source of a thump is usually difficult to determine, as the vibration is likely to be transmitted with development of sound in a different part of the engine. If the trouble is not revealed by careful inspection of the alignment of the engine or by the condition and adjustment of the working parts, indicator diagrams should be taken to determine whether there is good distribution of steam and whether the valve setting cannot be altered to obtain more cushion on the exhaust. If thumping persists after the valve setting has been changed to give liberal cushioning, it is suggested to determine whether the noise may not be due to looseness of the piston on the rod or of the rod in the crosshead; also note whether there is not vertical play of the connecting-rod brasses, and if the brasses are properly fitted and shimmed in place. It is also suggested that the crank and crosshead pins should be carefully calipered to determine whether they may not be worn out of round and need to be turned up or replaced with provision of new brasses.

Pressure of Steam Supplied to Throttle-Governed Engines

We have four 10-in. x 10-in. throttle-governed slide-valve engines used for driving paper machines. The exhaust is used mainly for heating the dryers in which the circulation of the exhaust is regulated by variation of 0 to 7 in. vacuum on the discharge of the dryers. Any excess exhaust goes to the heating system of the mill or is discharged at the atmosphere. Purchased steam enters the plant at 200 lb. gage pressure superheated 100 deg., but before it is supplied to the engines the steam is passed through a pressure-reducing valve and reduced to 105 lb. gage. Would it be more economical to raise our working pressure to 115 lb. gage or to reduce it to 90 lb. gage? J. E. R.

There would be no advantage in raising or lowering the working pressure, because for doing the same work the throttling governors on the engines, after being adjusted to the present speed, would reduce the steam to the present initial pressure in the steam chests of the engines. This can be understood if the main pressure-reducing valve is regarded merely as an auxiliary of the throttling governors to perform part of the reduction of the initial 200-lb. pressure to the steam-chest pressures necessary for driving the paper machines

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A.S.M.E. Boiler Code

REQUESTS for interpretations of the Boiler Code are acted upon by the Boiler Committee, their formulated replies being submitted to the Council of the American Society of Mechanical Engineers. The inquiries and replies are published from time to time in *Power*, with such explanatory comments and illustrations as seem advisable for a clear understanding of the interpretations on the part of engineers in general. The last group of interpretations published in *Power* was in the issue of Nov. 1, 1921.

Case No. 364—Inquiry: Is it necessary, as indicated in the appendix to the Boiler Code, to use an extra-thick tube for the fusible plug when used with a vertical fire-tube boiler, in accordance with the requirements of Par. 429 and 430?

Reply: It is the opinion of the committee that, inasmuch as Par. 429 permits of the use of a $\frac{3}{8}$-in. fusible plug, it would be desirable to insert it in a tube having a thickness of not less than 0.22 in. in order to allow insertion of at least four threads of the fusible plug.

Par. 429 specifies that the least diameter of fusible metal (in a fusible plug) shall not be less than $\frac{1}{2}$ in., except for maximum allowable working pressures of more than 175 lb. per sq.in., or when it is necessary to place a fusible plug in a tube, in which case the least diameter of fusible metal shall not be less than $\frac{3}{8}$ in.

Section *d* of Par. 430 specifies that in the case of vertical fire-tube boilers the fusible plug shall be located in an outside tube, not less than one-third the length of the tube above the lower tube sheet, and shall project through the tube wall not less than 1 in.

Case No. 365—In the hands of the Committee.

Cases No. 366 and 367—Annulled.

Case No. 368—Inquiry: Is it permissible, under the requirements of Par. 185 of the Boiler Code, to plane or mill down the plates forming the laps of circumferential joints to less than $\frac{1}{2}$ in. thickness?

Reply: It is the opinion of the committee that there is no objection to planing down the laps of circumferential joints to a thickness less than $\frac{1}{2}$ in. provided, however, there is sufficient strength left in the joint to conform with the requirements of Par. 184.

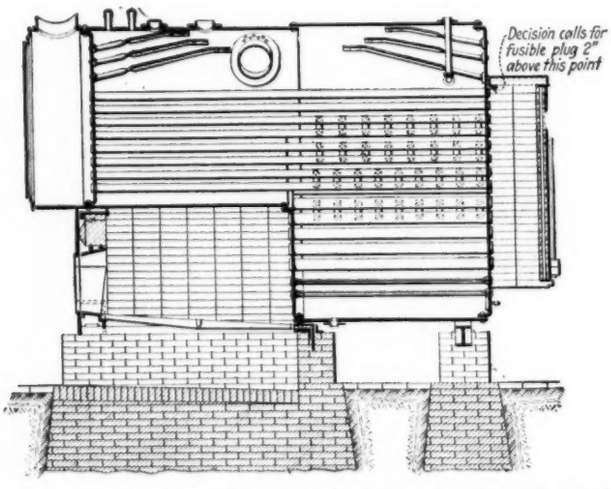


FIG. 1. (CASE NO. 372). ECONOMIC-TYPE BOILER, SHOWING REQUIRED LOCATION OF FUSIBLE PLUG

Par. 184 provides that the strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent that of the longitudinal joints of the same structure. Where tubes and stays carry 50 per cent, or more, of the load this figure may be reduced to 35 per cent. Par. 185 requires such joints to be planed down to $\frac{1}{2}$ in., if the plate is more than $\frac{7}{16}$ inch thick and is exposed to the fire or products of combustion.

Case No. 369—Inquiry: Is it necessary, under the requirement of Par. 195 of the Boiler Code, to increase the thickness of a dished head $\frac{1}{4}$ in. when a manhole is inserted, provided the manhole opening is reinforced?

Reply: It is the opinion of the committee that the requirement in Par. 195 for increase of $\frac{1}{4}$ in. in thickness is applicable in any case when a manhole is inserted in a dished head.

Par. 195 provides that where dished heads have a manhole opening, the plate thickness must be at least $\frac{1}{4}$ in. greater than is required for similar heads without a manhole.

Case No. 370—Inquiry: Is it permissible, under the rules in the Boiler Code, to construct a boiler drum 36 in. internal diameter built with the shell in one sheet $\frac{13}{16}$ in. thick, with one longitudinal seam having butt straps $\frac{1}{2}$ in. thick on each side? Information is also requested as to the maximum allowable working pressure as determined by the efficiency of the longitudinal seam and the tube-hole ligament.

Reply: It is the opinion of the committee that a boiler drum constructed as described does not conform to the requirements of Par. 19 of the Code. The committee is not in a position to determine the maximum allowable working pressure for constructions not permitted by the Code and would recommend that the question be taken up with the state authorities or insurance companies interested.

Case No. 371—Inquiry: Is it permissible to construct vertical fire-tube boilers of either the through-tube or submerged-tube types with the tubes welded in both the upper and lower tube sheets?

Reply: It is the opinion of the committee that Par. 250 was not intended to forbid rolling and welding at both ends of the tubes of a fire-tube boiler, when desired.

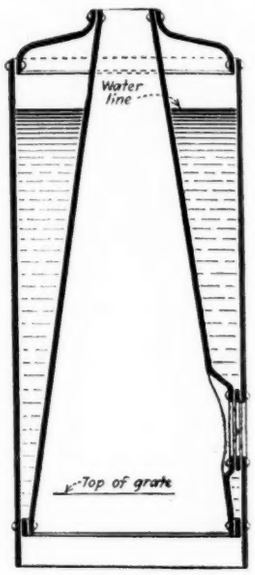


FIG. 2. (CASE NO. 373) BOILER WITH CONTINUOUS, UNSTAYED CONICAL FURNACE

Par. 250 reads as follows: "A fire-tube boiler shall have the ends of the tubes substantially rolled and beaded; or rolled and welded at the firebox or combustion-chamber end."

Case No. 372—Inquiry: An opinion is requested as to the actual distance above tubes at which the fusible plug should be inserted in Economic-type boilers under the requirement of Par. 430*r*. Is 1 in. above the upper row of tubes sufficient?

Reply: It is the opinion of the committee that, as this type of boiler is quite similar in construction to an h.r.t. boiler, an elevation of the fusible plug 2 in. above the upper row of tubes will be necessary to meet the requirements of Par. 430*r*.

Par. 430*r* states that each boiler must have one or more fusible plugs and that the location, in the Economic-type boiler, shall be in the rear head above the upper row of tubes. For horizontal return-tubular boilers it is specified that the fusible plug or plugs shall be located "in the rear head not less than 2 in. above the upper row of tubes, the measurement to be taken from the line of the upper surface of the tubes to the center of the plug, and projecting through the sheet not less than 1 in." The Economic-type boiler is illustrated in Fig. 1. The top of the upper row of tubes is indicated by the arrow point on the right. To place the fusible plug at least two inches above this point would evidently require the top of the back combustion space of the boiler illustrated to be raised in order that the plug might be in contact with the hot gases.

Case No. 373—Inquiry: Will the rules in the Boiler Code for calculation of the Adamson type of furnace apply to the design of conical furnace shown in Fig. 2, using the mean diameter of the cone as the nominal diameter of the furnace, and is it permissible in such construction to form the two vertical seams therein by autogenous welding?

Reply: It is the opinion of the committee that Par. 231 covers the construction described. Autogenous welding is not permissible in this type of boiler, except in those portions of the furnace which are to be stayed.

Paragraph 231 states that upper combustion chambers of vertical submerged tubular boilers, made in the shape of a frustum of a cone, when not over 38 in. in diameter at the large end, may be used without stays if figured by the formula for plain cylindrical furnaces (Par. 239), making *D* in the formula equal to the diameter at the large end. It also specifies that, when the large end has a diameter greater than 38 in., the portion over 30 in. in diameter must be fully supported by staybolts or gussets to conform to the provisions for the staying of flat surfaces.

Case No. 374—Inquiry: Does the requirement of Par. 256 of the Code, relative to the term: "machine driven," refer solely to hydraulic or other forms of pressure riveters, or will pneumatic riveters conform to this requirement?

Reply: It was the intent of the committee that the term "machine driven" should apply only to those types of riveting machines which are able to drive the rivets with sufficient pressure to fill the rivet holes and allow them to cool and shrink under pressure.

Par. 256 reads as follows: "Rivets shall be machine driven wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt."

What the New Census Shows

The returns from the 1920 Census of Manufactures, covering the year 1919, have at last been compiled and issued by the Government; scattering returns from local districts have been given out from time to time, but the totals for the United States have just been made public. Many interesting conclusions may be drawn from these figures; the more significant values are given here.

Table I gives the totals not only for 1919, but also for 1914, and shows the percentages of increase. In this table the term "primary horsepower" covers the capacity of whatever prime movers there were in each factory, added to the capacity of whatever motors were operated on purchased power. It thus represents the total rated power requirements of each factory, regardless of whether power was produced within the plant or was bought. It is well

TABLE I. SOME COMPARISONS BETWEEN THE TOTALS FOR THE UNITED STATES FOR 1919 AND 1914

	1919	1914	Per Cent Increase
Number of establishments	290,111	257,791	5.2
Persons engaged in manufacture	10,815,883	8,263,063	30.9
Proprietors and firm members	270,003	262,598	2.6
Number of salaried employees	1,447,761	964,217	50.1
Average number of wage-earners	9,098,119	7,036,247	29.3
Primary horsepower installed	29,573,207	22,533,374	31.2
Capital invested	$44,776,006,000	$22,790,980,000	96.5
Paid in salaries	2,893,046,000	1,287,917,000	124.6
Paid in wages	10,545,905,000	4,078,332,000	158.6
Paid for materials	37,380,124,000	14,368,089,000	160.2
Value of products	62,427,825,000	24,246,435,000	157.5
Value added by manufacture	25,047,701,000	9,878,346,000	153.6
Horsepower per person	2.73	2.73	0
Horsepower per wage earner	3.25	3.20	0.016

to remember, however, that it means installed capacity, and in some cases the machinery may not have been operating at full rating.

Near the end of the table the "horsepower per person" is shown. This is found by dividing the primary horsepower installed by the number of persons engaged in manufacture. It is of interest by way of showing to what a large extent industry of today depends upon machine-power instead of man-power. Thus, for every person in the manufacturing industry (including even properietors and salaried workers) there was used 2.73 hp. in performing the work of that industry. However, the wage earner is the man who actually uses or guides the mechanical power, and so perhaps the ratio of horsepower per wage earner would have greater significance; it is given at the bottom of the table and is shown to have increased slightly, from 3.20 to 3.25.

Table II draws a comparison between the different states for 1919 on the basis of the number of establishments, the number of persons in each establishment, the average number of wage earners, the installed horsepower, the horsepower per person and the horsepower per wage earner. It will be noted that the latter quantity varies widely, from a minimum of 1.9 for Florida to a maximum of 12.2 for Arizona. The changing value of these ratios among the different states might easily become the subject of interesting speculation as to its causes.

There is almost no limit to the facts and tendencies one may glean from data such as are given in these two tables. For instance, note that the number of establishments increased only 5.2 per cent, while the capital invested in them was almost doubled by an increase of 96.5 per cent, and the number of persons in the industry, together with the power installed, each increased about 30 per cent. So it seems that the tendency is to enlarge existing plants rather than to organize new enterprises; many have suspected this from personal observation. This is corroborated by the very slight increase of 2.6 per cent in the number of proprietors and firm members.

Another significant increase is that of 50.1 per cent in the number of salaried employees, as compared with 29.3 per

TABLE II. A COMPARISON OF THE DIFFERENT STATES

	Number of Establishments	Persons Engaged in Manufacture	Average Number of Wage Earners	Primary Horsepower	Horsepower per Person	Horsepower per Wage-earner
Alabama	3,654	120,889	107,159	628,376	5.2	5.9
Arizona	480	10,347	8,528	103,958	10.0	12.2
Arkansas	3,123	58,202	49,954	274,469	4.7	5.5
California	11,942	296,997	243,792	766,858	2.6	3.1
Colorado	2,631	44,729	35,254	206,309	4.6	5.9
Connecticut	4,872	338,033	292,672	664,691	2.0	2.3
Delaware	668	32,972	29,035	85,150	2.6	2.9
District of Columbia	595	14,101	10,482	33,079	2.4	3.2
Florida	2,582	82,986	74,415	139,456	1.7	1.9
Georgia	4,803	141,012	123,441	436,610	3.1	3.5
Idaho	922	16,268	13,917	73,876	4.5	5.3
Illinois	18,593	804,755	653,114	1,660,466	2.1	2.5
Indiana	7,916	330,145	277,580	1,095,912	3.3	4.0
Iowa	5,683	105,439	80,551	242,946	2.3	3.0
Kansas	3,474	77,010	61,049	234,110	3.0	3.8
Kentucky	3,957	83,954	69,340	247,573	2.9	3.6
Louisiana	2,617	112,523	98,265	388,605	3.4	3.8
Maine	2,995	99,284	88,651	554,878	5.6	6.2
Maryland	4,937	165,869	140,342	406,768	2.5	2.9
Massachusetts	11,906	812,527	713,836	1,729,878	2.1	2.4
Michigan	8,305	549,069	471,242	1,202,128	2.2	2.6
Minnesota	6,225	147,678	115,623	473,823	3.1	4.0
Mississippi	2,455	64,452	57,560	200,814	3.1	3.5
Missouri	8,592	245,739	195,837	477,303	1.9	2.4
Montana	1,290	20,692	17,160	153,491	7.5	9.0
Nebraska	2,884	49,076	36,521	125,814	2.6	3.4
Nevada	166	3,563	3,119	19,874	5.6	6.3
New Hampshire	1,499	90,332	83,074	349,138	3.9	4.2
New Jersey	11,059	603,427	508,921	1,147,072	1.9	2.3
New Mexico	387	6,646	5,736	17,260	2.6	3.0
New York	49,333	1,525,314	1,228,369	2,936,613	1.9	2.4
North Carolina	5,999	175,423	157,659	549,878	3.1	3.5
North Dakota	894	6,148	4,472	17,791	2.9	4.0
Ohio	16,125	882,934	730,733	2,894,443	3.3	4.0
Oklahoma	2,445	38,314	29,503	139,983	3.7	4.7
Oregon	2,707	68,005	58,559	304,346	4.5	5.2
Pennsylvania	27,974	1,324,121	1,136,210	4,454,736	3.4	3.9
Rhode Island	2,466	156,012	139,665	321,016	2.1	2.3
South Carolina	2,004	86,360	79,450	395,556	4.6	5.0
South Dakota	1,414	9,034	6,382	22,191	2.5	3.5
Tennessee	4,589	113,300	95,167	338,814	3.0	3.6
Texas	5,724	130,911	107,522	443,207	3.4	4.1
Utah	1,160	23,107	18,868	93,942	4.0	5.0
Vermont	1,790	38,845	33,491	185,095	4.8	5.5
Virginia	5,603	139,178	119,352	419,946	3.0	3.5
Washington	4,918	150,479	132,928	687,436	4.6	5.2
West Virginia	2,785	93,688	83,036	328,653	3.5	3.9
Wisconsin	10,393	317,899	263,949	881,007	2.9	3.3
Wyoming	576	8,095	6,634	17,869	2.2	2.7
Total for United States	290,111	10,815,883	9,098,119	29,573,207	2.7	3.2

cent for wage earners. While it is true that the distinction between wages and salary is not the same everywhere in regard to the kind of work that they are applied to, still the difference between these figures seems to bear out common observation again, and to indicate an increasing proportion of men who are not directly engaged in production. In other words, "overhead" is looming up larger on the balance sheet.

The student of labor problems can learn something from these figures. While the number of salaried employees increased 50.1 per cent, the total paid them in salaries increased 124.6 per cent; but the number of wage earners increased only 29.3 per cent, while the wages they received went up 158.6 per cent. How well this proves what has often been said, but sometimes not believed, that the so-called "middle-class" man, with a fixed salary, has been the

greatest sufferer from the rising prices of the period just before and during the war.

It should be mentioned that, in the detailed figures given out by the Census Bureau for each state, New York comes first and Pennsylvania second with but two exceptions—primary horsepower and capital invested. Pennsylvania led in these respects, with 4,454,736 hp. and $6,226,580,000 of capital, as compared with New York's 2,936,613 hp. and $5,998,763,000.

What Engineers Are Doing for the Sesqui-Centennial Exhibition

Of great and far-reaching importance is the movement that is now well under way for an international exhibition at Philadelphia in 1926 in commemoration of the one hundred and fiftieth anniversary of American Independence. A fine feature of the preparatory work that is being done is the enthusiastic co-operation that the engineers are giving through that venerable institution, the Engineers' Club of Philadelphia.

The plan is to organize a so-called "Sesqui-Centennial Exhibition" along the same general lines as the Panama-Pacific Exposition at San Francisco and the World's Fair at Chicago, although, of course, it is hoped to make this one greater than any that has gone before. Since it will commemorate American Independence, it seems entirely fitting that it should be held in Philadelphia, a city that is rich above all others in associations with the birth and early development of the United States.

The site to be chosen in Philadelphia, however, is another matter, as fourteen different locations are now being proposed as ideal. Naturally, those who put forward these sites are hardly disinterested, and so a careful comparison must be made on the basis of an accurate and impartial analysis of all the proposals. In the making of this analysis the engineers have found their opportunity to help. In answer to an invitation from those in charge of the project, the Engineers' Club has undertaken a systematic survey of the situation through the appointment of ten committees.

One of these is the General Committee, consisting of John Price Jackson, chairman, and J. A. Steinmetz, J. C. Wagner, Charles Penrose, S. M. Swaab and D. Robert Yarnall. The scope and chairman of each of the special committees are as follows: Statistics, W. Pool Parker; Civil Engineering, Benjamin Franklin; Transportation, N. B. Temple; Power and Light, Clayton W. Pike; Central-Station Service, W. C. L. Eglin; Communication, J. L. Kilpatrick; Public Information, H. F. Sanville; Co-operation with the Real Estate Interests, John Meigs; Co-operation with the Architects, D. K. Boyd. The real-estate men and the architects also are making investigations and are co-operating with the engineers.

These committees have made a study of all previous American and foreign expositions back as far as 1876, and have laid down the many requirements that an ideal site should meet. They are now rating the fourteen proposed locations on the basis of each separate requirement. The final report of the General Committee will combine the reports of the special committees and will assign to each of the fourteen sites a definite rating comparable to that of the others. It is hoped to complete this report by Jan. 21. No one site will be recommended, but in the true engineering spirit the figures will be presented to speak for themselves.

At a luncheon meeting of the club on Jan. 12, the project was discussed by John C. Trautwine, Jr., and John F. Lewis. Both speakers stressed the national and even international aspect of the exhibition, avoiding the provincial attitude of regarding it simply as a good thing for Philadelphia. Both looked upon it, in fact, as a powerful influence toward world peace.

It was about a year ago that the Sesqui-Centennial got under way at a public meeting called by the mayor; and on May 9 the "Sesqui-Centennial Exhibition Association" was duly incorporated under Pennsylvania law, having the right of eminent domain. This association will have full charge of the organization and conduct of the exhibition. There are now over 1,450 members, who pay annual dues of $10. There is a board of directors of twenty-five, which has an executive board comprising Mayor J. Hampton Moore, chairman, and John Gribbel, J. S. W. Holton, Alba B. Johnson, John Frederick Lewis and John H. Mason. Edward Robins is the corresponding secretary, and the headquarters are in the Bellevue-Stratford Hotel.

As will be noted, Mayor Moore has taken a leading part in the work, and on Jan. 5 he sent to the City Council a message proposing that the city guarantee $5,000,000 at once to meet the expenses of the exhibition. It is considered likely that this will pass in the near future.

How Pennsylvania Boiler Inspectors Co-operate

As the National Board of Boiler and Pressure Vessel Inspectors was organized not long ago to bring about co-operation among the boiler inspectors of the various states, so a somewhat similar association has been formed in Pennsylvania to secure co-operation among the various boiler inspectors of that state. The new body was organized at Harrisburg, Oct. 24, 1921, at a meeting called by Commissioner Clifford B. Connelly, and is known as the Association of Approved Boiler Inspectors of Pennsylvania. It has no official connection with the National Board, but is to co-operate in every way possible in the enforcement of the Pennsylvania boiler inspection laws, which are based on the A. S. M. E. Code. It is to hold one meeting a year at the same time as the departmental convention.

The object of the association may be said to be threefold. The most obvious purpose is to provide an easier means of co-operation among the individual inspectors; it was thought that they would feel freer to discuss their

THE OFFICERS OF THE ASSOCIATION

A. J. Bell, secretary treasurer; James Neil, chairman; W. J. Boyer, vice-chairman

problems in their own organization than they might otherwise have felt in taking them up individually with the Department of Labor and Industry, and would have a better chance to exchange experiences and profit by one another's mistakes and successes. Another important object is the stimulation of interest among the inspectors regarding their work, with the expected results that they will seek to improve their ability and to become better craftsmen. A third object is that the association may serve as a connecting link between the inspectors on the one hand and the Department of Labor and Industry on the other.

Membership in the association automatically includes every person who holds a certificate of competency or a commission as an approved inspector of steam boilers issued by the State of Pennsylvania, of whom the number is 645 at the present time. No fees are charged, and membership is not limited to residents of Pennsylvania.

The officers, who were elected at the organization meeting in Harrisburg, are well-known figures in Pennsylvania boiler-inspection circles. The chairman is James Neil, who is now fuel engineer with the United States Bureau of Mines at Pittsburgh, and who was formerly chief boiler inspector of the Pennsylvania Industrial Commission. The vice-chairman is W. J. Boyer, who is an inspector of the Fidelity and Casualty Co. of New York, and who has been in its employ in the State of Pennsylvania for 25 years. The secretary-treasurer is A. J. Bell, state steam boiler inspector for Allegheny County, Pa., who has been connected with that office for the last 22 years.

News in the Field of Power

Governor Miller Takes Up Power Problems in Message

In his annual message to the State Legislature on Jan. 4 Governor Miller, of New York, gave his ideas on water-power legislation in considerable detail and proposed that an effort be made to cut down waste in the power and heating plants of state institutions. On the latter point he said:

I believe that economies can be effected in the operation of the state's power and heating plants, which in the aggregate have a large consumption of coal. I recommend that an efficiency engineer be employed to visit and supervise the operation and equipment of those plants. He might appropriately be attached to the office of the State Engineer.

The Governor mentioned the many past years of discussion and disagreement about water-power legislation, and pointed out that the legislature, at its last session, adopted a definite policy and has been trying it out during the last year, during which time the newly created Water Power Commission has considered 21 applications for power development. He explained that no licenses have so far been granted (although two preliminary permits were issued Dec. 31), because the policy has been one of caution, so that whatever faults there are in the law will be found and corrected before any harm has been done. He made clear his position that the State's water-power resources can best be developed by private enterprise under proper supervision and regulation by the state. He insisted, however, upon a general use of the power so developed, saying:

The state should grant licenses for the development of power for general distribution, not for private use. With a general distribution assured, with the power to fix rates and to regulate service, capitalization and secured debts of the licensee safeguarded, the maximum public benefit from the development of the potential water power within the state will unquestionably be secured through private enterprise.

He urged again his recommendation of the previous year, that the State Constitution be amended to permit the use for power development of some of the 3 per cent of forest preserve lands that may be used under existing laws for reservoirs, canals, etc.

In discussing the proposed use of the surplus water of the barge canal, he emphasized the need of realizing that navigation is the primary purpose of the waterway, and that any power development must be subordinate to that requirement. For this reason he said that the only way of making certain that the needs of navigation would not be sacrificed for power demands would be to put the two functions under a unified control. He admitted that this is done theoretically in the Water Power Act, which puts the Superintendent of Public Works in charge of the matter, but he believes that this provision would not work out in practice and that pressure would successfully be brought to bear to secure for mill owners on the canal water that may be needed for navigation. For this reason he prefers that the State itself should take the initiative and make the development, saying:

If the State can lease surplus water to advantage, I can perceive no reason why it cannot sell at the busbar any power that it may develop. By that means alone can the available power be developed without incurring great risk of subjecting the use of canal water to influences that might prove detrimental to navigation. I therefore recommend the passage of an act authorizing the Superintendent of Public Works to develop the use for power purposes of the surplus waters of the canal where practicable, such power to be sold at public letting, and I recommend an appropriation of $1,000,000 to start at once the development at Crescent Dam and Visscher's Ferry.

Wanted — Facts, Not Literature

A MAN does not need to be a trained writer to turn out articles that Power will print. He does not need a technical education. He does not need a typewriter. What he must have is practical information that other men can use. It must be first-hand—from experience, not from books. It must be definite—not general. Better ways of handling power-plant apparatus, operating results, methods of saving fuel—information like that is wanted.

This can come to a man only through his daily work, and the practical man generally feels that he cannot write well enough to tell about it in an interesting article. He does not need to. The staff of Power can write the article, if given the facts. How good the story will be depends, not on how well it was written in the first place, but on the practical value of what it tells.

If you know something that other power-plant men could use in their work, give us the facts, and let us write the article. We pay for ideas.

A. A. E. to Hold Conference for Practicing Engineers

The American Association of Engineers has announced the program for a conference of practicing engineers for Washington's Birthday, February 22, at the Congress Hotel, in Chicago.

All practicing engineers, whether members of the Association or not, are invited to attend. The following subjects are included in the tentative program: "How to Sell Engineering Service"; "Experiences of the Practicing Engineer with Licensing"; "Publicity for Practicing Engineers"; "Cost Accounting for Engineering Service"; "Bookkeeping for an Engineering Office"; "How to Uphold the Standards of Service and Fees"; "Amendment of Schedules of Service and Fees, and Providing for Other Branches, such as Mining and Mechanical"; "Computing Practicing Engineers' Income Tax."

Heating Engineers To Hold Annual Meeting in New York, Jan. 24-26

The American Society of Heating and Ventilating Engineers has announced for its 28th annual meeting a program that includes some features of considerable interest to power plant men. Headquarters will be at the Hotel Pennsylvania, New York City, and the affair will take up Tuesday, Wednesday, and Thursday, Jan. 24-26.

A number of technical papers will be presented, of which the following may be suggested as having the most direct bearing on power plant problems.

Tuesday: "Heating, Ventilating and Mechanical Equipment of the Hotel Pennsylvania," by Arthur K. Ohmes (including an inspection trip); "Improvements in the Process for Cleaning and Drying Air Mechanically," by William K. Baldwin.

Thursday: "The Control of Blower Motors," Henry H. Issertel; "The Underfeed Stoker," by Frank A. DeBoos; "Heat Transfer for Conduction and Convection," by W. K. Lewis, W. H. McAdams and T. H. Frost.

A feature of interest to many will be the Research Session on Wednesday afternoon, at which results of the experiments conducted in the last year at the Engineering Experiment Station will be made public.

The important social events will be the reception and dance on Tuesday evening, the annual banquet on Wednesday and a theatre party on Thursday.

The secretary is Casin W. Obert, 29 West 39th St., New York City

Two Water-Power Applications

The Mendota Irrigation District, 414 Mattei Building, Fresno, Cal., has applied to the Federal Power Commission for a preliminary permit to cover a project on Kings River, in Fresno County, involving the construction of a dam, a conduit and a power house of 12,000 hp. capacity for pumping purposes.

The Caddo River Power and Irrigation Company, of Little Rock, Ark., has asked for a preliminary permit for a project on the Ouachita River, near Hot Springs, Arkansas, covering the construction of three dams and power houses. The primary power is estimated at 22,300 hp., and the plant capacity is to be 55,000 hp. The power is to be used for public utility purposes.

Expansion of Power Facilities Expected

General indications seem to be that the year that has just started will see considerable activity in the way of the construction of new plants and the extension of others to meet their increasing requirements. It is reported that the Duquesne Light Co. has ordered a second 60,000-kw. unit for the Colfax Station, which was completed last year with one unit in operation. This plant is expected to take its place among the largest in the country, for its ultimate capacity is to be 360,000 kw. in six units. With the addition of the second unit the company is to install three more substations.

Another company that has made definite arrangements for expansion is the New Orleans Railway and Light Co., which is to install a new 20,000-kw. turbine and is to make other improvements and additions to its power plant and distributing system.

It is understood that the officers of Dwight P. Robinson Co., which has secured contracts for the new work of these two companies, is at present doing preliminary engineering work on a number of large projects and reports that construction activity at this time is on the increase.

Electrolysis Data

The American Committee on Electrolysis has completed its 1921 report, which supersedes its preliminary report of 1916. The Committee is headed by Bion J. Arnold, and comprises three representatives from the A.I.E.E. and from each of several other engineering societies. Many of the outstanding questions of electrolysis can not yet be answered, and so the report should not be considered as final; it is rather a progress report, including such statements of fact and discussion on methods of testing and preventing electrolysis as the members of the Committee have been able to agree upon unanimously.

The report has been put on sale by the American Institute of Electrical Engineers, 33 West 39th Street, New York City, at $1 per copy. It will doubtless prove useful to those interested in preventing the electrolytic deterioration of underground pipes or cables.

Coosa River Plant Now Complete

On the last day of 1921, the sixth and final unit at the Lock 12 power house of the Alabama Power Co. on the Coosa River was put in service, thus completing the full installation at the plant of 110,000 hp. in six units. It is understood that the flow of water is not enough to keep the six units running throughout the year, but it is felt that this additional capacity will be needed to meet the demand for power in the coming year.

Thomas W. Martin, president of the Alabama Power Co., expects an increase in demand for power of approximately 40,000 hp. in 1922. He says that the company is doing everything possible to provide for this additional demand, which, he believes, indicates a continued improvement in business and an approach to normal conditions before many months have passed.

New Publications

Switching Equipment for Power Control. By Stephen Q. Hayes. Published by McGraw-Hill Book Co., Inc., New York, 1921. Cloth; 6 x 9 in.; 463 pages; 272 illustrations. Price, $4.

The term switching equipment, as applied in the title of this book, is used in its broadest sense, in that it embraces all the equipment necessary to open and close the circuit and also to protect the circuit under all abnormal conditions. The material is compiled largely from the author's own articles appearing from time to time in various publications. These articles have been rewritten and brought up to date. In arranging the material, the idea has been to describe first the switching devices approximately in the order in which they were developed, following this with a consideration of the main connections desired in a power plant and the means of carrying these connections out to obtain the maximum amount of security and flexibility with the minimum cost.

The book is divided into 16 chapters: Switches; automatic protection and fuses; carbon breakers; oil switches; relays; switchboard meters; instrument transformers; lightning arresters; regulators; industrial-control apparatus; switchboards — general information; small switchboards; large hand and electrically operated panel switchboards for direct-current generators and rotary converters; hand-operated alternating-current switchboards; busbars and wiring general information; and breaker structures. Although the main object of the book is to furnish operating engineers the information that will help them keep the equipment in condition and explain what may be expected of the apparatus, it should be of help to students of electrical engineering and power-plant designers. American practice forms the basis for the descriptions, and the book should fill a long felt need in the particular field it covers.

Personals

R. J. Bauereisen has been appointed officer in charge of power plants at Fort Mills, Corregidor, P. I.

Bert E. Clough has taken charge of the Indianapolis plant of the Indiana Refrigerating Company.

Allan D. Colvin is now general manager of the Hartford Electric Light Co., with which he has been connected since 1911. He succeeds E. F. Lawton, who resigned from ill health.

R. A. Ross, a fellow of the A.I.E.E., has left his work as a member of a municipal commission in Montreal, Canada, to resume his engineering practice in the firm of R. A. Ross & Co., of Montreal, which was founded in 1896.

T. M. Jasper, assistant professor of mechanics in the University of Wisconsin, has been put in charge of the investigation of the fatigue of metals at the Engineering Experiment Station of the University of Illinois, replacing Prof. J. B. Kommers, who returns to the University of Wisconsin.

G. W. Atkinson has been appointed superintendent of power and maintenance with the Gilbert and Barker Manufacturing Co., of West Springfield, Mass. He has recently resigned his position at the Springfield Armory, where he had been electrical engineer since 1917 in charge of design, construction, installation and operation of power plants, buildings, etc.

Society Affairs

Coming Conventions

American Society of Civil Engineers—Annual meeting at New York City, Jan. 18-20. Secy., Elbert M. Chandler, 29 West 39th St., New York City.

American Society of Heating and Ventilating Engineers—Annual meeting at New York City, Jan. 24-26. Secy., C. W. Obert, 29 West 39th St New York City.

American Institute of Electrical Engineers—Midwinter convention at New York City, Feb. 15-17. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

Baltimore Section, A.I.E.E., is to meet Jan. 20 for a paper by C. F. Hirschfeld on "The Use of Electricity for Industrial Heating."

Cincinnati Section, A.S.M.E., is to hold a joint meeting Jan. 19 with the Cincinnati Engineers' Club, at which "Gas Producers" will be the topic.

Colorado Section, A.S.M.E., will meet Jan. 27 for a talk by Robert C. Newbury, of the Denver Gas and Electric Light Co., on "Public Utility Problems."

Chicago Section, A.S.M.E., will hold a dinner meeting Jan. 20, at 6:30, at the Sherman Hotel. Addresses will be made by president Dexter S. Kimball and by S. W. Stratton, director of the Bureau of Standards.

The Iowa Engineering Society is holding its annual meeting this week at Sioux City, Jan. 17-20, with headquarters at the Woodbury County Court House. Most of the program relates to civil engineering, but the mechanical-electrical section has scheduled two power papers for Wednesday afternoon, Jan. 18. They are "The Proper Distribution of Power Costs," by Charles F. Schoonmaker, chief engineer of the Quaker Oats Co., and "Superheating in Steam Power Plants," by R. M. Ostermann, vice-president of the Superheater Company.

Business Items

The Orton & Steinbrenner Co., of Chicago, has made arrangements with Walter Hasendahl, 1213 Fuller Ave., Los Angeles, Cal., as its representative.

The London Steam Turbine Co., of Troy, N. Y., has secured all the rights, patents and privileges of the Steam Motors Co., of Springfield, Mass., has received a charter and has been capitalized at $500,000. W. A. J. London, turbine engineer and president of the Steam Motors Co., will be president and chief engineer. Offices have been established in the Myrick Building, in Springfield, and plans are being made for a new building.

Trade Catalogs

Motor Generator Sets — Ridgway Dynamo and Engine Co., Ridgway, Pa. A well illustrated bulletin covering general-purpose motor-generator units up to about 500 kw. in capacity.

Switches and Panels—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Catalog 12-A, 8 x 11 in., 64 pages, describing safety switches and panel boards, and giving dimensions and prices.

Air Pumps and Compressors—Pennsylvania Pump and Compressor Co., Easton, Pa. A 16-page bulletin covering single-stage, straight-line air compressors and vacuum pumps of both belt- and motor-driven types.

Unaflow Engines — Mesta Machine Co., Oliver Bldg, Pittsburgh, Pa. Bulletin "U," of 24 pages, which explains the theory of the Stumpf unaflow engine and is well illustrated with photographs and diagrams.

Piping Practice—M. J. Dougherty Co., 27th and Washington Ave., Philadelphia, Pa. Bulletin P-1, dealing with the design and erection of piping systems, and aiming to give the busy executive the essentials of modern piping practice.

Making One-Piece Baffles—Quigley Furnace Specialties Co., 26 Cortlandt St., New York, N. Y. Bulletin No. 52, most of which is reprinted from *Power* of Oct. 25, p. 638, describing the process of making baffles of poured refractory concrete.

Centrifugal Pumps — The Goulds Manufacturing Co., Seneca Falls, N. Y. Bulletin 123, consisting of 16 pages of specifications, photographs, etc., and covering steam turbine-driven centrifugal pumps especially adapted for boiler-feed and similar purposes.

Steam Turbines — Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Circular No. 1094B, 32 pages, attractive and well prepared. It deals with large steam turbines, and briefly with the generators that go with them. It should be valuable for study, because it is not so much a simple description of the different types of turbines as it is a comparison between their principles and advantages.

Combustion-Precision Instrument Co., 21 Halsey St., Newark, N. J. Three educational bulletins explaining scientific methods of saving coal in the boiler room are being distributed by the company with its latest catalog of boiler efficiency and gas plant instruments. The catalog is of large size but the bulletins are especially interesting. One consists of excerpts from a bulletin of the Bureau of Mines, another is called the "A. B. C. of Conbustion in Boiler Settings," and the third consists in a reprinted paper on flue-gas analysis read by Abram T. Baldwin before the A. S. M. E.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 2, 1922	Jan. 9, 1922
Pool 1,	New York	$3.15	$2.90@3.40
Pocahontas,	Columbus	2.15	2.00@2.25
Clearfield,	Boston	2.05	1.80@2.35
Somerset,	Boston	1.80	1.60@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	1.85	1.60@1.90
Hocking,	Columbus	1.90	1.65@1.90
Pittsburgh No. 8	Cleveland	2.00	1.95@2.10
Franklin, Ill.,	Chicago	2.90	2.75@3.00
Central, Ill.,	Chicago	2.50	2.25@2.75
Ind. 4th Vein,	Chicago	2.55	2.40@2.75
Standard,	St. Louis	1.85	1.80@1.90
West Ky.,	Louisville	1.90	1.50@2.25
Big Seam,	Birmingham	2.10	1.90@2.30
S. E. Ky.,	Louisville	1.60	1.65@1.70

New York—On Jan. 11 Port Arthur light oil 22@25 deg. Baumé 4½c. per gal. 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago — Jan. 5, for 24@28 deg. Baumé, 80@85c. per bbl.; 32@36 deg., 2⅜@2⅝c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh — On Jan. 10, f.o.b. refinery, Pennsylvania, 36@40 deg., 4½c. Oklahoma 24@30 deg., 85@90c. per bbl.; gas oil, 32@34 deg., 2½c. per gal.; 36@38 deg., 2⅝c., 38@40 deg., 3¼c. per gal.

St. Louis—Jan. 7 prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 85c. per bbl.; 26@28 deg., 90c.; 28@30 deg., 90c.; 32@34 deg., 3c. per gal.

Philadelphia—On Jan. 9, 26@28 deg. Baumé, Oklahoma, 80@90c. per bbl.; 30@34 deg., Oklahoma (group 3) 2½@3c. per gal.; 16@20 deg., Seaboard, $1.15@$1.25 per bbl.

Cincinnati—Dec. 21, for 26@30 deg. Baumé, 5½c.; Diesel 32@34 deg., 6c. per gal.; distillate 38@42 deg. 7c. per gal.

Cleveland — Dec. 21, 26@30 deg. Baumé, 4½c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Tuskegee—The Treasury Dept., J. A. Wetmore, Supervising Archt., soon receives bids for the construction of a United States Public Health Service Hospital here. About $1,250,000. Mechanical equipment, $750,000.

Cal., Burlingame—The San Mateo Union High School Dist., is having plans prepared for a group of high school buildings. About $480,000. W. H. Weeks, 369 Pine St., San Francisco, Archt.

Cal., Oakland—The Pacific Gas & Electric Co., 445 Sutter St., San Francisco, is receiving bids for an 8 story, 50 x 100 ft. office building on 17th and Clay Sts., here. About $350,000.

Cal., San Diego—The San Diego Consolidated Gas & Electric Co., Timken Bldg., plans to expend $1,500,000 for improvements and extensions in 1922, to include increase of horsepower of the generating departments from 24,000 to 44,000, also make extensions to gas mains and the pole lines throughout the city and county. H. H. Jones, Pres. and Genl. Mgr.

Cal., San Francisco—The Crocker Estate Co., Crocker Bldg., has had preliminary plans prepared for a 38 story bank and office building on Market, Post and Montgomery Sts. Willis Polk & Co., Hobart Bldg., Archts.

Cal., San Francisco—W. Fitzhugh, Mill Bldg., is having plans prepared for a 9 story office building on Post and Powell Sts. Reid Bros., 105 Montgomery St., Archts.

Cal., San Francisco—T. McDougall, c/o J. L. Stewart, Archt., Claus Spreckels Bldg., is having revised plans prepared and soon receives bids for an 8 story apartment on Octavia St. About $150,000; and a 5 story apartment on Francisco and Larkin Sts. About $400,000.

D. C., Washington — A. E. Walker Co., Southern Bldg., is having plans prepared for an apartment hotel on 17th and De Salles Sts., N.W. About $2,000,000. B. F. Beresford, Southern Bldg., Archt.

Fla., Orlando—The San Juan Hotel will soon receive bids for a hotel here. About $400,000. W. L. Stoddart, 9 East 40th St., New York City, Archt. and Engr.

Ind., Bloomington — The Bloomington Brick & Tile Co. plans to build a brick and tile plant to include twelve 32 ft. kilns, two radial brick stacks and two 150 hp. boilers. About $200,000. Private plans.

Ind., Butler—The Bd. Educ. will soon award the contract for a 2 story, 95 x 120 ft. school and power plant. About $150,000. A. H. Ellwood & Sons, Haynes Bldg., Elkhart, Archts.

Ind., Elkhart—The Elkhart Hotel Corp., 212 Murdock Bldg., will soon award the contract for a 6 story, 83 x 139 ft. hotel. About $350,000. Nicol Scholer & Hoffman, Nicol Bldg., Lafayette, Archts. Noted Jan. 10.

Ind., Elkhart — The Superior Coal Co. plans to build a 2 story, 83 x 45 ft. ice plant. About $10,000. R. L. Simmons, 201 South Main St., Archt.

Ind., Garrett—The Garrett Ice Co., Inc., plans to build an ice plant. About $40,000. Private plans.

Ind., Indianapolis—The Bd. of Sanitary Comrs., City Hall, plans to build a power plant. About $300,000. C. Hurd, 1405 Merchants Bank Bldg., Engr.

Ind., Indianapolis—The Guarantee Building Corp., Fletcher Trust Bldg., plans to build a 12 story office building on Meridian Place and Monument St. About $750,000. Rubush & Hunter, American Central Life Bldg., Archts.

Ind., Newcastle—The Indiana Village of Epileptics will receive bids until Jan. 31 for 12 buildings including a 1 story, 64 x 100 ft. laundry and 1 story, 60 x 74 ft. power plant. Total cost about $400,000. McMeans & Tripp, 510 Majestic Bldg., Indianapolis, Engrs. Noted Dec. 27.

Ind., Rushville—The Indianapolis & Cincinnati Traction Co., C. Henry, Pres., Germana Bldg., plans to build a 70 mile extension to railway from here to Cincinnati, O. Plans include new power stations at Brookville & Metamora, also addition to power plant here. Total cost about $4,000,000. A. H. Moore, Eng.

Ind., South Bend—The Bd. Educ. is having plans prepared for a 2 story, 135 x 200 ft. school. About $600,000. Freyermuth & Maurer, 654 Farmers Trust Bldg., Archts.

Kan., Sabetha—The city will soon receive bids for 3 miles of pipe line and developing springs also install pumping equipment. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

La., New Orleans — C. Kornmesser, National Machinery Exch., Room 310 Marine Bank Bldg., is in the market for a 20 ton ice manufacturing or refrigerating machine, Frick, Jork or Sterling preferred (used).

Mass., Lowell—The Boott Mills Armory St., plans to build an electric generating plant at cotton mills here. About $40,000. A. P. Stafford, 66 Bway., Engr.

Mass., West Springfield—The town, K. K. Chandler, Chn. of Comn., 76 Bliss St., plans to build a 3 story junior high school on Elm St. About $350,000. Architect not selected.

Me., South Windham—The Windham Mfg. Co., Textile Mills, plans to build a hydro electric generating plant. About $40,000. A. P. Stafford, 66 Bway., Lowell, Engr.

Mich., Bay City — The Aetna Portland Cement Co., 412 Union Trust Bldg., Detroit, is having plans prepared for a cement plant including 3 rotary kilns, etc. About $1,000,000. Mechanical equipment will include crushers, grinding mills, conveyors and equipment for complete power plant. Private plans.

Minn., Morris—The city, F. J. Haight, City Mgr., rejected bids of Dec. 27 for new filteration plant, settling basin and aerator, also installation of filters and pump equipment. About $40,000. C. F. Tweed, 531 Metropolitan Bank Bldg., Minneapolis, Engr. Noted Dec. 20.

Mo., Joplin—The School Bd., J. Wolf, Secy., Bartlett Bldg., plans to build a 3 story junior high school, including a hot air heating and a ventilating system. About $400,000. Architect not selected.

Mo., Kansas City—J. S. Joy, Archt., 2001 West 39th St., Chicago, Ill., is preparing plans for an 8 story, 150 x 300 ft. cold storage and ice plant here. About $1,00,000. Owners name withheld.

Mo., Odessa—The city is having plans prepared for a reservoir, pumping station, water main extensions, etc. About $80,000. E. E. Harper, 3031 Park Ave., Kansas City, Engr.

N. J., Atlantic City — R. S. DeGolyer, Archt., 7 South Dearborn St., Chicago, Ill., is receiving bids for a 12 story, 335 x 350 ft. hotel including a steam heating system on Albany Ave. here, for W. G. Souders & Co., 208 South LaSalle St., Chicago, Ill. About $5,000,000.

N. J., Madison—The Bd. Educ. is having plans prepared for a high school. About $500,000. Guilbert & Betelle, 2 Lombardi St., Newark, Archts. and Engrs.

N. Y., Brooklyn — The South Brooklyn Savings Institute, 160 Atlantic Ave., is having sketches made for a bank on Court St. and Atlantic Ave. About $500,000. McKenzie, Voorhies & Gmelin, 1123 Bway., New York City, Archts.

N. Y., Brooklyn — The West 10th St. Construction Co. ,Inc., c/o Shampan & Shampan, Archts., 50 Court St., New York City, will soon receive bids for a 6 story, 95 x 100 ft. apartment. About $300,000.

N. Y., New York—The 132 West 36th St. Corp., c/o R. T. Lyons, Archt., 342 Madison Ave., is having plans prepared for a 12 story office and loft building on 36th St. About $500,000.

N. Y., New York—The Bd. Educ. received bids for a heating and ventilating system for P. S. No. 55 on St. Paul Pl., Park Ave., Washington Ave. and East 170th St., from W. J. Olvany, 100 Charles St., $51,983; Wells & Newton Co., Ave. B and 17th St., $55,750; Kenney & Newhall Co., 33 Old Bway., $56,200. Noted March 1.

O., Cincinnati — The Norton Broadway Machinery Co., 238 Bway., is in the market for a 700 to 1,000 ft. belt driven air compressor, 100 lb. pressure and 100 to 125 hp. motor, 3 phace, 60 cycle, 220 volt, induction type with starter to operate compressor, also contractors equipment, hoisting engines, etc.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., is having plans prepared for a 2 story high school on N. E. section. About $750,000. W. R. McCormack, East 6th St. and Rockwell Ave., Archt.

O., Cleveland—The Cleveland Real Estate Board Bldg. Co., c/o Heaton-Pennington, Williamson Bldg., plans to build an office building. About $500,000. Architect not selected.

O., Cleveland — J. Grant & Son, 10600 Euclid Ave., are in the market for a 10 hp., 3 phase, 220 volt motor (used).

O., Cleveland—The Perfection Auto Parts Co., 410 Lakeside Ave., N.W., is in the market for one 20 and one 25 hp. motors, 220 volt (used).

O., Columbus—The Bd. Educ., E. L. McCune Clk., will receive bids until Jan. 30 for a 2 story, 200 x 375 ft. high school on East Broad St. About $944,000. Howell & Thomas, 2032 Euclid Ave., Cleveland, Archts.

O., Columbus—J. F. Denson, Archt., 5 North LaSalle St., Chicago, Ill., is preparing plans for a 6 story, 152 x 232 ft. apartment including a steam heating system on Broad and Parkwood Sts. About $1,500,000. Owner's name withheld.

O., Columbus — The Deshlee Estate, J. Deshlee Exec., East Broad St., is having plans prepared for a 16 story, 62 x 187 ft. hotel on Broad and 3rd Sts. About $300,000. F. L. Packard, New Hayden Bldg., Archt.

O., Van Wert—The council has approved plans for a new system of sanitary sewers with pumping station and disposal plant. About $400,000. E. G. Bradbury, Wyandotte St. and 1st Ave. and the Jennings Lawrence Co., Hartford Bldg., both of Columbus, Engrs.

Ont., Collingswood—The council, J. H. Duncan want prices on installation of motor generator and storage batteries to replace wet battery system, also additional fire alarm boxes and fire hydrants.

Ont., Conestogo — The council, H. W. Elber, plans to install electric lighting system. About $25,000.

Ont., London—The Ontario Creameries, Ltd., are in the market for complete refrigeration and ice cream mak'.g equipment. About $30,000.

Ont., Merlin—The Council, M. A. Farquharson, plans electric lighting and power distribution system. About $28,000. M. Lawlor, 190 University Ave., Toronto, Engr. Noted Mar. 15.

Ont., Walkerton—The council, G. D. McKay, Mayor, is having surveys made for an electric lighting and power distribution system. About $40,000.

Ont., Wiarton—The council, J. McDonald, Mayor, plan improvement to water works pumping plant including the installation of electrically operated pumps, and a large gasoline engine. Prices wanted on equipment. About $25,000. J. Symon, Engr.

Pa., Phila.—The city received bids for foundations for Belmont pumping station from Robbins Constr. Co. 1137 North Front St., $24,308.50; Mitchell Howsworth Co., 30th and Leigh Ave., $25,654.80; and Nelson Pedley Constr. Co., 1320 Race St., $26,742. (a) Piping for Queens Lane pumping station, (b)—Larners Point pumping station from the Acme Machine Co., 316 North 17th St., (a) $13,168, (b) $4,800; J. H. Gold, 6074 Girard Ave., (a) $14,480, (b) $6,100; W. K. Mitchell & Co., 2940 Ellsworth St., (a) $11,333, (b) $4,939.34. Patent connections at Queen Lane and Belmont Filters from A. B. Smith Co., Phila., $6,950. Furnishing steel connecting flues for economizers from the Phila. Stack & Tank Wks., Phila., $7,386; Phila. Boiler Wks., 1737 Filbert St., $7,485. Noted Jan. 3.

Pa., Sharpsville—The Coolrite Mfg. Co., is in the market for Ethyl Chloride refrigerating machines, 1 ton capacity.

Va., Norfolk—The Treasury Dept., J. A. Wetmore, Acting Supervising Archt., Navy Dept., Wash., D. C., will receive bids until Jan. 25 for an ice making and refrigerating plant to be installed in the main hospital building for the United States Public Health Service Hospital here on Tanners Creek site.

Wash., Tacoma—The Tacoma Ice & Refrigerating Co., South 26th and Adams St., plans to build a cold storage and ice making plant (capacity of ice plant 100 tons per 24 hrs. and storage capacity 400,000 cu.ft.) About $250,000.

Wis., Neillsville—E. Scheelis is in the market for refrigerating machinery, power machinery and dairy equipment.

Wis., Sheboygan — The Amer. Hide & Leather Co. plans steam ash shute system and ash handling equipment. F. Schneller, Mgr. Engineer not selected.

Wis., Shorewood (Milwaukee P. O.)—District No. 4 will receive bids until Jan. 2 for a 2 story addition to school and a heating plant on Atwater Rd. About $230,000. R. Messmer & Bro., 221 Grand Ave., Archts.

Wis., Stevens Point—The Wisconsin Valley Electric Co., 507 Main St., is receiving bids for equipment for electric distribution system including switchboard transformers, etc. About $10,000. Private plans.

Wis., Verona—The Dane County Bd., c/o M. Sommers, 512 West Wilson St., Madison, is having plans prepared for a 1 story, 45 x 50 ft. power house here. About $40,000. A. D. Conover, Tenney Blk., Madison, Archt.

CONTRACTS AWARDED

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for gas, water, sewer and electrical distribution systems at the Naval Base Hospital to the General Electric Engr. Co., 449 West 42nd St., New York City, $52,400. Noted Jan. 10.

Conn., New Haven — The New Haven Hospital, 330 Cedar St., has awarded the contract for a 4 story, 46 x 125 ft. private ward building on Davenport Ave. to Connor & Haggerty Co., 902 Chapel St. About $400,000. A steam heating system will be installed. Noted Sept. 6.

Ill., Clearing—The Railway Ice Co., 209 South LaSalle St., has awarded the contract for a 2 story, 100 x 150 ft. ice plant to E. W. Sproul Co., 2001 Pershing Rd. About $120,000.

Ind., Michigan City—The Michigan City Hotel Co. has awarded the contract for a 6 story, 86 x 165 ft. hotel on Franklin and 47th Sts. to H. Koelln, 317 East 5th St. About $400,000.

Mass., Boston—The City Hospital Bldg., Harrison Ave., has awarded the contract for two 6 story, 40 x 43 ft. and 28 x 43 ft. hospital buildings, also a 3 story addition to present hospital to J. Bowen Co., 184 Dudley St., $493,000.

N. J., Linden—The Warner Quinlin Co., 79 Wall St., New York City, has awarded the contract for a refinery and asphalt plant to include a power plant to J. Ferguson Co., United Bank Bldg., Paterson. About $2,000,000.

N. Y., Brooklyn — J. Tanuzzi, c/o F. Savignano, Archt., 6005 14th Ave., will build two 4 story apartments on 7th St. and 19th Ave. About $300,000. Work will be done by separate contracts.

N. Y., Kew Gardens (Jamaica P. O.)—The Roanoke Constr. Co., Inc., c/o Shampan & Shampan, Archts., 50 Court St., Brooklyn, will build two 4 story apartments on Union Turnpike here. About $375,000 each. Owner will build by day labor.

N. Y., Marcy—The State Hospital Comn. Capitol, Albany, has awarded the contract for a cold storage building and kitchen for Marcy State Hospital to C. J. Burgess Co., Ltd., Marcy, $130,970. Noted Jan. 3.

N. Y., Thiells—L. F. Pilcher, State Archt., Albany, has awarded the contract for the construction of 8 cottages and a dining room at Letchworth, to Fitzpatrick & MacArthur, Proctor Bldg., New York, $129,921. Heating and ventilating system to E. W. Thompkins Co, 27 Grand St., Albany, N. Y., $23,985.

O., Cleveland—The city has awarded the contract for furnishing Booster pump and equipment for sewage treatment works to Stone, Carlisle & Hammond Co., Frankfort Ave., $2,067. Noted Nov. 29.

Okla., Broken Bow—The city has awarded the contract for a waterworks system and filteration plant including equipment, etc. to the Ladd Constr. Co., 716 Scarritt Bldg., Kansas City. About $120,000. Noted Aug. 2.

Va., Charlottesville—The city has awarded the contract from a 2,000,000 gal. capacity filter; a 1,000,000 gal. reservoir; 5,000 ft. 16 in. pipe line to W. T. Thurston & Co., Merchants Natl. Bank Bldg., $130,000. Two 60 hp. motor centrifugal pumps will be installed.

W. Va., Charleston—The Diamond Ice & Coal Co., 805 Kanawha St., will build a 2 story, 100 x 100 ft. ice plant. About $50,000. Work will be done by separate contracts.

Wis., Viroqua—The city has awarded the contract for a reservoir and equipment for pumping station including pump and compressor to the Wisconsin Foundry & Machine Co., 623 East Main St., Madison. About $15,450.